October 1993

IDAHO SUPPLEMENTATION STUDIES ANNUAL REPORT 1991-1992

Annual Report 1991

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IDAHO SUPPLEMENTATION STUDIES

ANNUAL REPORT 1991-1992

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ABSTRACT

Idaho Supplementation Studies (ISS) will help determine the utility of supplementation as a potential recovery tool for decimated stocks of spring and eummer chinook salmon Oncorhvnchus tshawvtscha in Idaho. The objectives are to: 1) monitor and evaluate the effects of supplementation on presmolt and emolt numbers and spawning escapements of naturally produced salmon; 2) monitor and evaluate changes in natural productivity and genetic composition of target and adjacent populations following supplementation and; 3) determine which supplementation strategies (broodstock and release stage) provide the quickest and highest response in natural production without adverse effects on productivity.

Field work began in 1991 with the collection of baseline data from treatment and some control streams. Full implementation began in 1992 with baseline data collection on treatment and control streams and releases of supplementation fish into several treatment streams. Field methods included snorkeling to estimate chinook salmon parr populations, PIT tagging summer parr to estimate parr-to-smolt survival, multiple redd counts to estimate spawning escapement and collect carcass information. Screw traps were used to trap and PIT tag outmigrating chinook salmon during the fall outmigration. Spring and fall emigrants will be trapped in 1993. Weirs were used to trap and enumerate returning adult salmon in select drainages.

Useful findings during the 1991 and 1992 field seasons include:

Chinook salmon parr population estimates were very low in most streams, typically less than 10% of estimated carrying capacities. Error bounds were usually higher than our goal of 30% of the parr estimate. In order to reduce this variability, we will need to increase the sample size, and consider habitat type and distance to redds as covariates.

Redd counts have also been very low (ranged from 2 redds in White Cap Creek to 66 redds in Marsh Creek). One exception was the South Fork Salmon River above the weir, where 454 redds were counted in 1992 (446 in the South Fork Salmon River and 8 in Curtis Creek). This was the result of 723 females released above the weir to spawn (100 females trucked to Stolle Meadows and 623 released at the weir.

Due to the low seeding levels, it was difficult to PIT tag 500 summer parr in all streams. The densities were too low in some streams to warrant tagging.

At least 500 fall outmigrants were PIT tagged at all the traps except the Red River trap. It was removed 10 to 14 days early.

Trap efficiencies ranged from 6.6% (Pahsimeroi River) to 41.9% (Crooked Fork Creek hatchery fish).

INTRODUCTION

Idaho Supplementation Studies (ISS) was developed to help define the potential role of supplementation in managing Idaho's anadromoue fisheries (IDFG 1991) and as a recovery tool for the basin (NPPC 1987, STWG 1988). Research associated with this program will help determine the best broodstock, rearing and release strategies for rebuilding natural populations of chinook salmon in various streams, and the effects of these activities on target and non-target natural populations.

ISS is being conducted in two phases. Phase I is completed and included formation of the Idaho Supplementation Technical Advisory Committee (ISTAC), development of a comprehensive experimental design and database (Bowles and Leitzinger 1991), and initial collection of baseline genetic, physical and biological data.

The research plan is a cooperative project involving all the members of the ISTAC. The committee is made up of representatives from the U.S. Forest Service (USFS) Intermountain and Northern regions, U.S. Fish and Wildlife Service (USFWS), Nez Perce Tribe (NPT), Shoehone-Bannock Tribes (SBT), Northwest Power Planning Council (NPPC), Bonneville Power Administration (BPA), Idaho Cooperative Fish and Wildlife Research Unit (ICFWRU), and Idaho Department of Fish and Game (IDFG). Their roles were to technically review and provide input on the research design and coordinate with their respective management, research, and user groups. This ensures that long-and short-term management plane of respective agencies and tribes will not compromise the supplementation research design and that management and research concerns of the respective agencies and tribes were represented in the supplementation research design. Through a subcontract with IDFG, the ICFWRU assisted directly in the development of the experimental design, with particular emphasis on the genetic and ecological effects of supplementation on natural populations.

Implementation (Phase II) began in May 1992. The ISTAC will continue technical advisory and agency coordination roles, as well as help insure quality control among cooperators. Responsibilities for implementation and evaluation are currently shared among IDFG, ICFWRU, NPT, SBT, and USFWS. IDFG has taken the lead role in planning and coordination, and will also take the lead in pulling information together as it develops. Each cooperator is responsible for analyzing and reporting annually on their components of the overall Experimental Design. This report represents initial results from the IDFG component, and includes: chinook salmon parr population estimates and PIT tagging; emigrant trapping and PIT tagging; spawning escapement estimates; broodstock collections; and spawning, rearing, marking, and releasing supplementation fish. We have also attached subcontract reports for genetic profile analysis (ICFWRU, Attachment A; WDF, Attachment B) and small scale studies (ICFWRU, Attachment A). IDFG will complete a more comprehensive report in 1996, synthesizing information from all the cooperators collected during the first five years of this study.

The goal of the ISS is to rebuild natural populations of Idaho's chinook salmon to fishable levels (IDFG 1991).

OBJECTIVES

The project objectives are:

1. Monitor and evaluate the effects of supplementation on presmolt and emolt numbers and spawning escapements of naturally produced chinook salmon.

2. Monitor and evaluate changes in natural productivity and genetic composition of target and adjacent populations following supplementation.

3. Determine which supplementation strategies (broodstock and release stage) provide the quickest and highest response in natural production without adverse effects on productivity.

4. Develop supplementation recommendations.

In Idaho, we have the opportunity to address several questions associated with two unknowns: "Can supplementation work?" and "What supplementation strategies work beet?" These specific questions are:

1. Does supplementation of existing chinook salmon populations in Idaho enhance natural production?

2. Does supplementation with existing hatchery stocks establish natural populations of chinook salmon in areas of Idaho where chinook salmon were extirpated?

3. Does supplementation of existing chinook salmon populations in Idaho reduce natural productivity of target or adjacent populations below acceptable levels (e.g. replacement)?

4. How often is supplementation required to maintain populations at satisfactory levels?

5. Can existing hatcheries and broodstocks be used effectively to supplement target populations within local or adjacent subbasins?

6. Is there an advantage to developing new, localized broodstocks with a known natural component for supplementation of existing natural populations?

7. Which life stage released (i.e. parr, preemolt, emolt) provides the quickest and highest response in rebuilding natural populations?

8. What effect does life stage released have on existing natural productivity and genetic composition?

These questions relate directly to questions 2, 3, 6, and 7 specified as important critical uncertainties by the Supplementation Technical Work Group (STWG 1988). In addition to addressing these questions with general application to the Basin, our research will provide important case history evaluations of several supplementation programs in Idaho.

STUDY AREA

ISS represents a state-wide research effort incorporating treatment and control streams throughout the Clearwater River and Salmon River drainages. The study includes eight treatment and eight control streams in the Salmon River drainage (Figure 1) and 12 treatment and three control streams in the Clearwater River drainage (Figure 2). The 31 streams and the responsible agency are listed in Table 1. IDFG supplementation crews concentrated on five streams in the Salmon River drainage and five in the Clearwater River drainage. Table 2 lists these streams, the number of strata, the number of snorkel sites per strata, and channel type of each strata.

Most study streams are relatively sterile, draining granitic parent material associated with the Idaho batholith (IDFG et al. 1990; NPT and IDFG

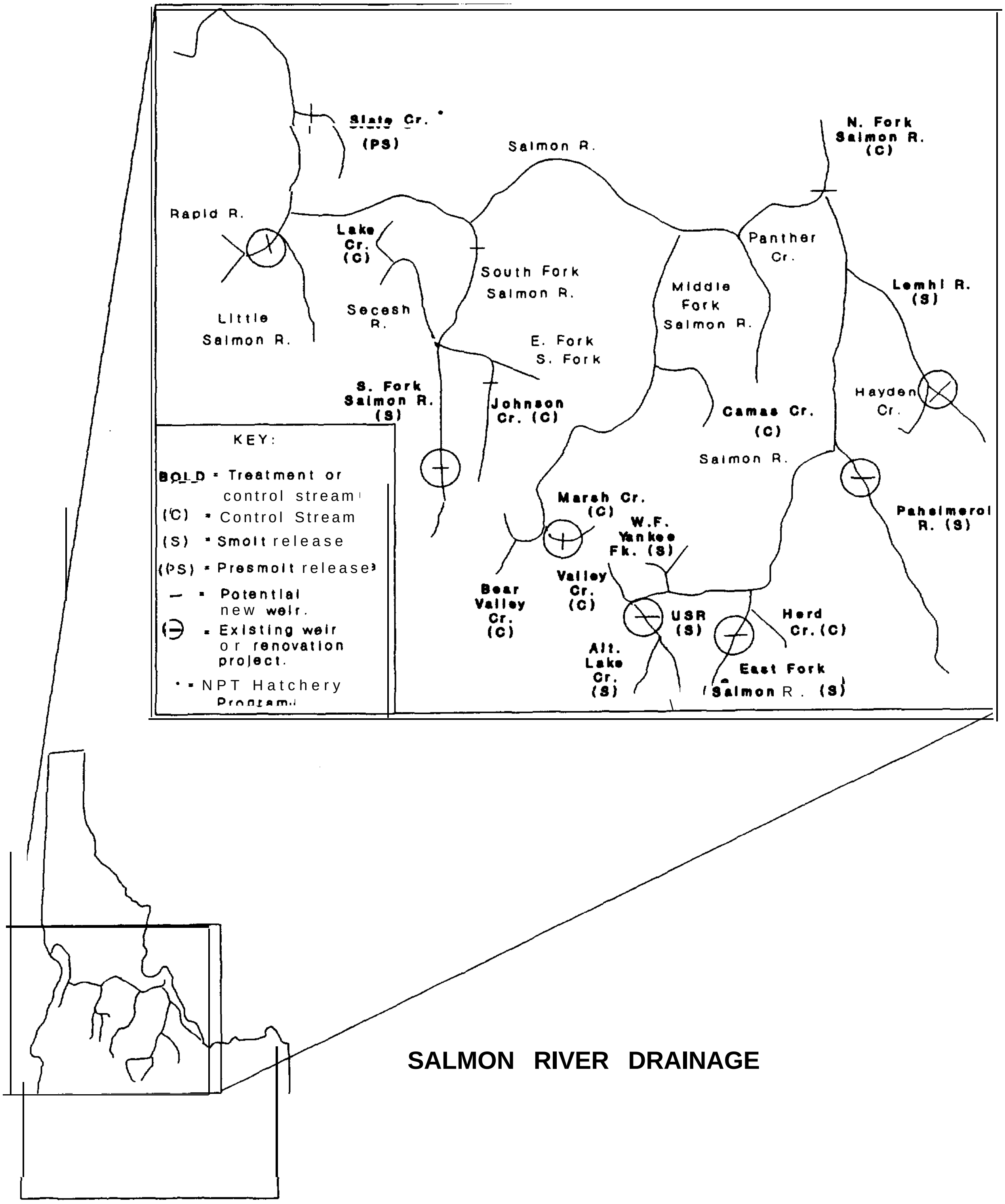


Figure 1. Treatment and control streams in the Salmon River drainage associated with Idaho Supplementation Studies.

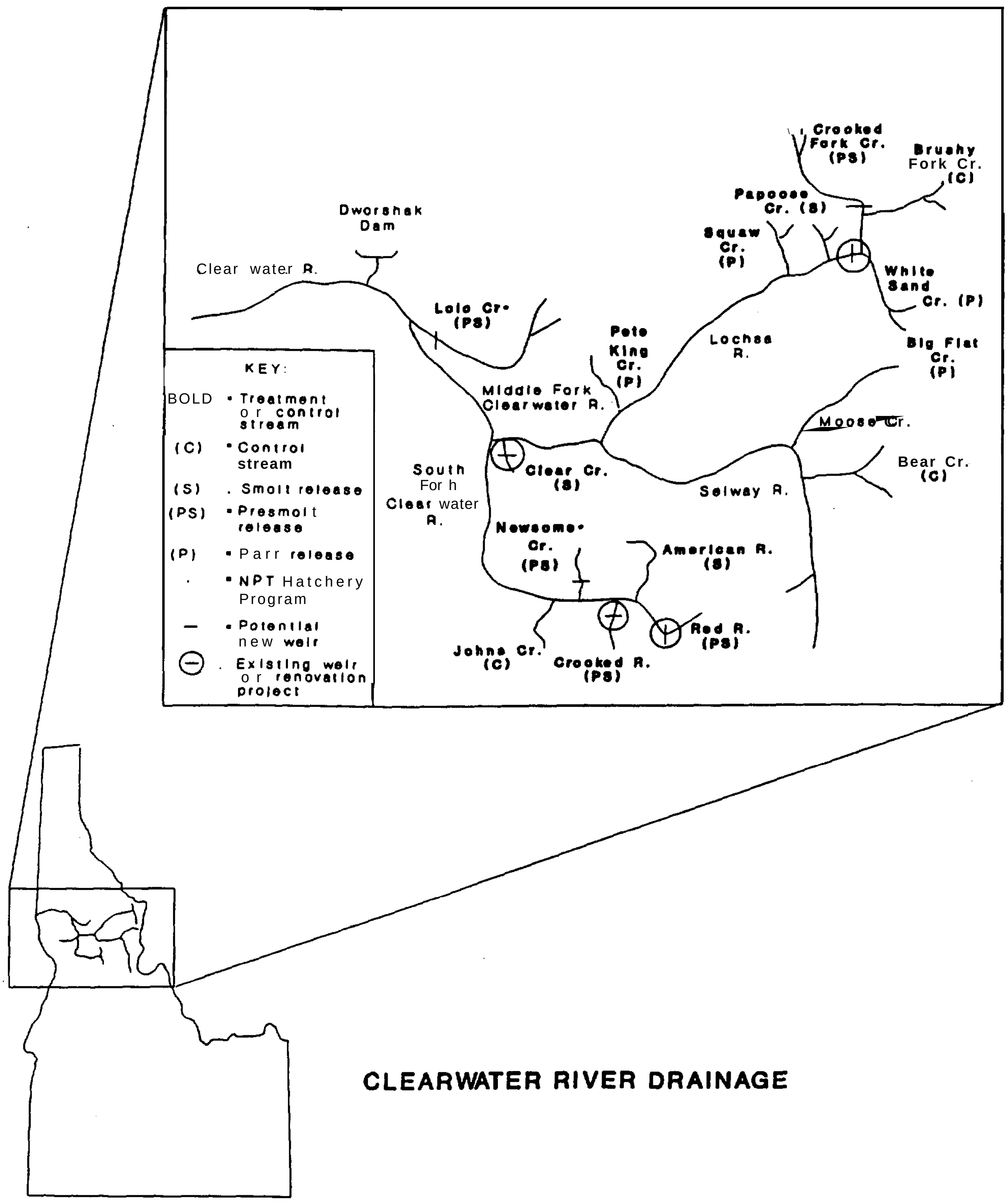


Figure 2. Treatment and control streams in the Clearwater River drainage associated with Idaho Supplementation Studies.

Table 1. ISS study streams and responsible agencies, summer 1992.

AGENCY	TRIBUTARY/STREAM	CONTROL STREAM	TREATMENT STREAM
IDFG IDAHO SUPPLEMENTATION STUDIES CREW 1	NORTH FORK SALMON RIVER	YES	NO
	MARSH CREEK	YES	NO
	SULPHUR CREEK	YES	NO
	WHITE CAP CREEK	YES	NO
	JOHNSON CREEK	YES	NO
IDFG IDAHO SUPPLEMENTATION STUDIES CREW 2	PAHSIMEROI RIVER	NO	YES
	CROOKED FORK CREEK	NO	YES
	BRUSHY FORK CREEK	YES	NO
	WHITE SAND CREEK	NO	YES
	BIG FLAT CREEK	NO	YES
IDFG GENERAL PARR MONITORING CREWS (BPA PROJECT 91-073)	RED RIVER	NO	YES
	AMERICAN RIVER	NO	YES
	JOHNS CREEK	YES	NO
IDFG INTENSIVE SMOLT MONITORING CREWS (BPA PROJECT 91-073)	CROOKED RIVER	NO	YES
	ALTURAS LAKE CREEK	NO	YES
	UPPER SALMON RIVER	NO	YES
UNITED STATES FISH AND WILDLIFE SERVICE	PETE KING CREEK	NO	YES
	CLEAR CREEK	NO	YES
NEZ PERCE TRIBE	LOLO CREEK	NO	YES
	SQUAW CREEK	NO	YES
	PAPOOSE CREEK	NO	YES
	NEWSOME CREEK	NO	YES
	SLATE CREEK	NO	YES
	SECESH RIVER /LAKE CREEK	YES	NO
SHOSHONE-BANNOCK TRIBES	VALLEY CREEK	YES	NO
	WEST FORK YANKEE FORK RIVER	NO	YES
	EAST FORK SALMON RIVER	NO	YES
	HERD CREEK	YES	NO
	SOUTH FORK SALMON RIVER	NO	YES
	BEAR VALLEY CREEK	YES	NO
UNIVERSITY OF IDAHO	LEMHI RIVER	NO	YES

Table 2. Salmon River and Clearwater River drainage streams eampled by Idaho Supplementation Studies in 1992.

STREAM	TRT/CNT	STRATA	# SECTIONS	CHANNEL TYPE
		SALMON RIVER DRAINAGE		
NORTH FORK SALMON R.	C	1	15	B
		2	15	B
		3	9	B
Total:			39	
PAHSIMEROI R.	T	1	20	C
MARSH CR.	C	1	22	C
		2	10	C
KNAPP CR.	C	1	10	C
Total:			44	
JOHNSON CR.	C	1	20	C
		2	6	B
		3	8	C
		4	3	B
Total:			37	
SULPHUR CR.	C	1	7	B
		2	22	C
Total:			29	
		CLEARWATER RIVER DRAINAGE		
CROOKED FORK CR.	T	1	3	C
		2	5	B
		3	9	B
		4	13	B
HOPEFUL CR.	T	1	3	B
Total:			33	
WHITE SAND CR.	T	1	18	B
BIG FLAT CR.	T	1	12	C
BRUSHY FORK CR.	C	1	0	B
		2	2	B
		3	18	C
		4	4	C
SPRUCE CR.	C	1	3	B
Total:			27	
WHITE CAP CR.	C	1	6	B
		2	3	B
		3		B
CANYON CR.	C	1	1	B
Total:			10	

1990). Several streams in the eastern part of the Salmon River drainage are more fertile resulting from basaltic parent material. The study streams are predominantly low to moderate gradient "headwater" streams with B- and C-channel characteristics (Rosgen 1985). Water quality is generally high with minimal contaminants and acceptable water temperatures. Habitat quality is fair to excellent with some localized riparian degradation, sedimentation, channelization, and irrigation withdrawal from multiple-use land management practices (IDFG et al. 1990; NPT and IDFG 1990).

Fish communities are relatively similar throughout the study streams. Anadromous fish include wild, natural and hatchery-produced spring or summer chinook salmon and summer steelhead O. mvkiss. Resident fish comprise a mix of native bull trout Salvelinus confluentus, cutthroat trout O. clarki, northern squawfish Ptvchocheilus oreuonensis, redside shiner Richardsonius balteatus, sculpin Cottus spp., dace Rhinichthvs spp., suckers Catostomus spp., rainbow trout, mountain whitefish Prosopium williamsoni, and introduced brook trout S. fontinalis.

METHODS

Final evaluation of supplementation is dependent on the response of adult escapements to treatments. But, several interim production and productivity evaluation points have been established to serve as a baseline and for initial feedback on population responses to treatments. This report focuses on parr abundance, PIT tagging parr, fall and spring outmigration estimation and PIT tagging for outmigration survival estimates, as well as redd counts. Refer to the ISS Experimental Design for a more detailed discussion of these evaluation points (Bowles and Leitzinger 1991).

Parr Abundance

Streams were stratified according to Rosgen's (1985) channel classification system (i.e. "C" channel indicates a meandering low gradient reach; "B" channel indicates a higher gradient confined channel). Initial stratifications were done using U.S. Geological Survey (USGS) 7.5 mintopographic maps. Aerial photographs and field validations were used to check stratifications prior to sampling.

Study sites were selected by a stratified-systematic procedure (Steel and Torrie 1980). Within each strata, snorkeling transects were located approximately every 400-800 m (1/4 - 1/2 mi). Distances between transects varied according to accessibility, stream habitat types (i.e. pools, riffles, runs and pocket water), and number of juvenile chinook salmon in surrounding transects. Transects were comprised of a pool/riffle sequence, or 50 m of uniform habitat, and they ranged from 30-50 m in length. Ten to 44 transects were snorkeled per drainage depending on stream size, accessibility, and expected variance. Chinook salmon parr populations were estimated, for each stratum, and the entire stream (Schaeffer et al. 1979).

Several of the streams sampled in 1991 were not sampled by ISS crews in 1992. The responsibility for sampling these streams has been taken over by the various ISS cooperators (Table 1).

Transects were sampled using Idaho's standardized snorkeling techniques (see Appendix A). IDFG ISS personnel consisted of two snorkeling crews of five divers each. The general parr monitoring (GPM; BPA Project 91-073) crew assisted with snorkeling on three streams, and the intensive smolt monitoring (ISM; BPA Project 91-073) crew assisted with snorkeling, PIT tagging, and redd counts on three additional study streams (Table 1).

Each transect was divided into subsections by stream habitat type and fish were recorded within their respective habitats. Length and width measurements were recorded for each habitat to determine densities (number/100 m^2) per habitat. The date, time, water temperature, and visibility were also recorded. All sections were photographed (Polaroid and 35 mm) and flagged for future identification.

Physical Habitat

Physical habitat surveys were recorded on two to three transects per stratum. Vertical drop, percent gradient (vertical drop/total transect length X 100), depth, substrate composition, and conductivity were measured. Vertical drop was measured, with a hand held surveyors transit and a stadia rod, as the elevation drop between the upper and lower transect boundaries. Depth and substrate composition was determined at 1/4, 1/2, and 3/4 points across each width measurement. Surface substrate composition was estimated using a view box (30 cm X 30 cm) to approximate the percent of sand/silt (<3 mm), gravel (4-64 mm), rubble (65-256 mm), boulder (257-2,048 mm) and bedrock (>2,049 mm) (Platts et al. 1983).

PIT Tassinq

Juvenile chinook salmon (i.e. summer parr) were PIT tagged following completion of snorkeling. Snorkelers aided in locating the fish. Collection of juveniles was possible only from streams with relatively high summer parr densities. Our goal was to tag a minimum of 500 parr per study stream. This number should ensure approximately 60 detections at the lower Snake River dams (Kiefer and Forster 1990; Buettner and Nelson 1990). Collection was done with electrofishing, seining, or a combination of both.

Fish were collected for PIT tagging when stream water temperatures were less than 20°C. Juveniles less than 55 mm (fork length) were not tagged. A Smith-Root (Model 15-B with Honda EX-350 Generator) backpack electrofishing unit was used in waters with sufficient conductivity. In streams with low conductivity, collection methods were electrofishing and seining (1.8 m X 15.2 m with 6 mm green mesh).

Juvenile chinook salmon PIT tagging procedures were defined by Kiefer and Forster (1991) and the PIT Tag Steering Committee (1992). PIT tagging data was recorded by using a PIT Tagging Station (Biomark Inc., Boise, Idaho) following methods outlined in Prentice et. al. 1990. No more than 20 juveniles were anesthetized (MS222) at one time and equipment was sterilized in a 70% ethanol solution to reduce transmission of disease. Juveniles were held for 24 h to observe for lost tags and delayed mortality. Released fish were dispersed throughout the capture transect.

Fall Emiqrants

Rotary screw traps (EG Solutions, Corvallis, Oregon) were used to trap fall emigrant juvenile chinook salmon. Our goal was to PIT tag a minimum of 500 fish throughout the migration period. Tagged juveniles were released approximately 1.6 km upstream to estimate trap efficiency. Recaptures were released immediately downstream of the trap. Length and weight data were taken from summer parr PIT tag recaptures. They were also released downstream of the trap. All other salmonids captured were identified, measured, and released at the trap.

Screw traps were installed in Red River and Crooked Fork Creek, in the Clearwater River drainage, and Marsh Creek, South Fork Salmon River, and Pahsimeroi River, in the Salmon River drainage. Traps were installed in September and operated through November. We removed the Marsh Creek trap because the flows were insufficient to rotate the cone of the trap. The screw traps were located below hatchery weirs on the South Fork Salmon River and Pahsimeroi River, 400 m upstream of the mouth on Red River, and 3.2 km upstream of the mouth on Crooked Fork Creek. Traps were checked daily. Juveniles were anesthetized and tagged on the day captured. On the Pahsimeroi River, escaped hatchery juveniles (adipose clipped) were tagged, recorded as hatchery fish, and released with the wild fish.

Spawning Escapement

Weir8

Existing weirs were manned by IDFG hatchery personnel with the exceptions of the Lemhi River weir (manned by ICFWRU personnel) and Marsh Creek (not operated). Adult chinook salmon were trapped, counted, sexed, aged, and inoculated with erythromycin. All fish were passed above the Lemhi River weir to spawn naturally. These fish were not inoculated. A percentage of the run was passed above all the other weirs to spawn naturally. At least one-third of each sex was passed above the Sawtooth, Pahsimeroi, and South Fork Salmon River weirs. An additional 100 pairs were trucked above the South Fork Salmon River weir to spawn naturally. Fifty percent of the adult returns to the East Fork Salmon River weir were passed for natural production. All the adult salmon were passed at the Crooked River weir, while two-thirds were passed at the Red River weir. The weir was not in place at the Powell facility, so no broodstock was collected for Crooked Fork Creek supplementation in 1992.

Redd Counts

Redd counts were conducted in all streams to document spawning escapement and spatial spawning distribution. Redds were censused by ground crews throughout all possible spawning areas as outlined in IDFG Redd Count Manual (Hassemer 1991). All carcasses encountered were measured (fork length), sexed, and aged (estimate of years in ocean). Where possible, unspent eggs were counted to ascertain percent spawned and scales were taken. Estimates of age and sex were recorded for live adults on redds. Redd counts were conducted after peak spawning periods (Hassemer 1991). Remote streams were censused once and accessible streams were censused two or three times at 1 week intervals. Redds were flagged to avoid duplicate counts. All redds were marked on aerial photographs or USGS 7.5 min series topographical maps.

Broodstock Collection

Broodstock collection for supplementation began in 1991. All adult collections during 1991 and 1992 were by hatchery personnel at existing weirs used for general hatchery production programs (Appendix B). Hatchery personnel incorporated adult allocation and spawning protocols identified in the ISS experimental design (Bowles and Leitzinger 1991).

Rearing, Marking, and Releases

Supplementation fish were reared in existing hatcheries and satellite facilities following standard hatchery practices. Supplementation began in the summer of 1992. All treatment fish (i.e. hatchery reared) had representative numbers PIT tagged to evaluate relative survival from time of release to detection at the lower Snake River dams. Juveniles were PIT tagged in the hatchery prior to release with the exception of the Crooked Fork Creek release. Treatment fish had a minimum of 700 fish (both summer parr and fall presmolts) PIT tagged. All treatment fish were marked initially with a right or left pelvic fin clip to enable evaluation of adult returns and ensure differentiation from natural adults for broodstock collection. Supplementation fish were released on-site or trucked to multiple release sites in each study stream.

RESULTS

Parr Abundance and PIT Tagging

Juvenile chinook salmon and steelhead abundance was estimated for 10 (1991) and 16 (1992) streams snorkeled by ISS and other IDFG research crews (Table 1, Appendix B and C). Chinook salmon population estimates ranged from 78-29,804 during 1991. Chinook salmon densities ranged from 0.00-26.94 fish/100 m^2 (Figure 3, Appendix B). The 1992 chinook salmon estimates range from zero in Big Flat Creek and Johns Creek to a high of 39,178 parr in the Pahsimeroi River. Chinook salmon densities during 1992 ranged from 0.00-22.06 fish/100 m^2 (Figure 4, Appendix C).

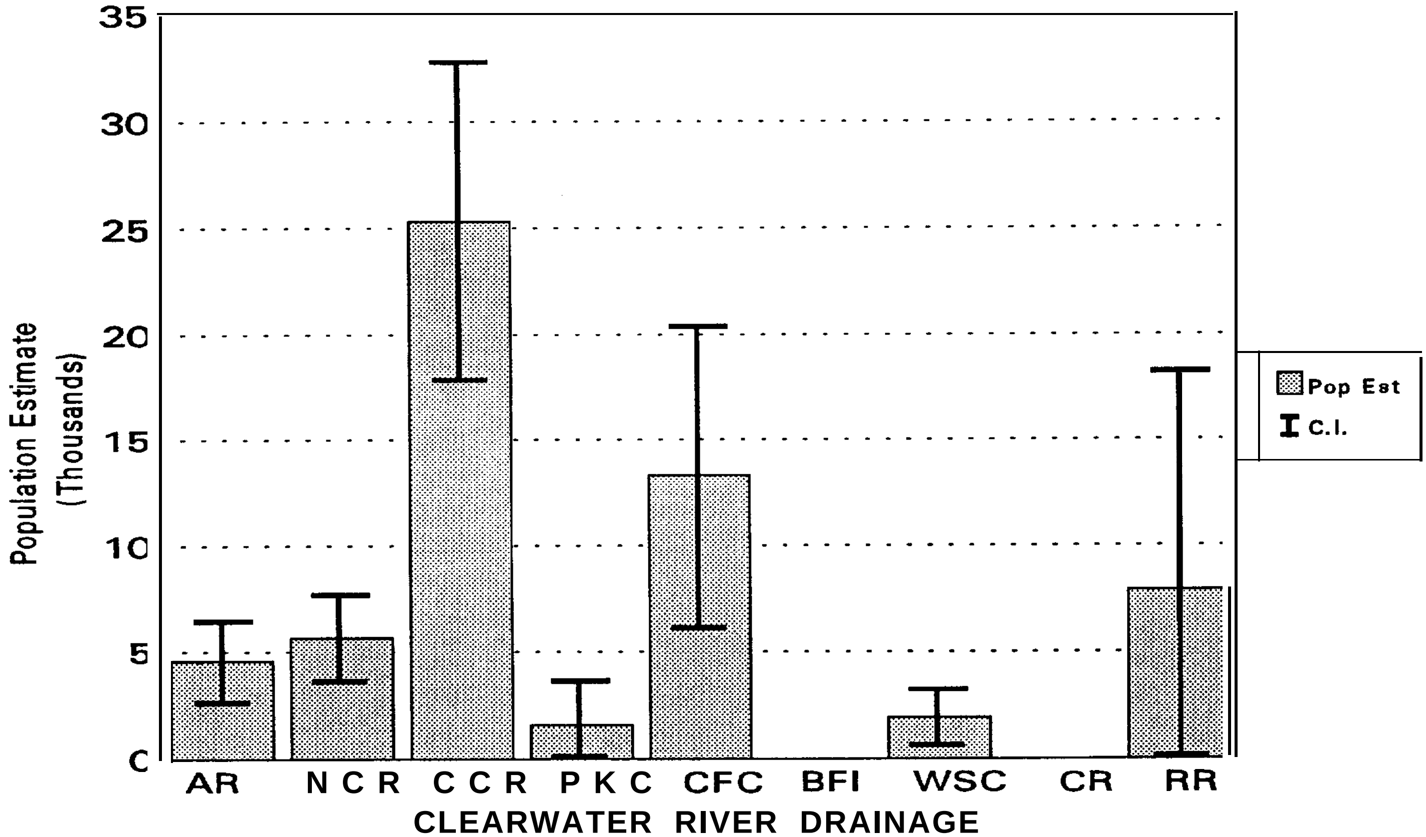
ISS crews PIT tagged 2,213 chinook salmon parr during 1992 (Table 3). PIT tag numbers ranged from a high of 662 in Johnson Creek to a low of 230 in Brushy Fork Creek. Twenty-four hour mortality ranged from a high of 5.8% (Red River) to a low of 0.4% (North Fork Salmon River). Table 4 lists the National Marine Fisheries Service's (NMFS) summer parr PIT tagging results. Data from 10 of the 17 streams will be incorporated into ISS.

Physical Habitat

The physical habitat data is being summarized and put into a database.

Fall Emisrants and Pit Tagging

Fall outmigration trapping began September 14, 1992 and ended December 9, 1992 (tables 5, 6, and 7). Between 435 and 1,081 chinook salmon emigrants were captured and tagged at each screw trap site (Table 5). Trap efficiencies ranged from 6.6-41.9%. Twenty-four hour trapping and tagging mortality ranged from 0.0-1.6%. Other fish trapped in the rotary screw traps include: bull trout, cutthroat trout, brook trout, mountain whitefish, juvenile steelhead, and Pacific lamprey Entosohenus tridentatus. Our estimates of total fall emigrants ranged from 1,805 in Red River to 8,273 in Pahsimeroi River (Table 7). This represents a minimum estimate because the traps were installed after a late summer storm event that moat likely resulted in many parr emigrating (Russ Kiefer, IDFG personal communication). The percent of summer parr emigrating in the fall ranged from 0.3%-4.1% in our study streams.



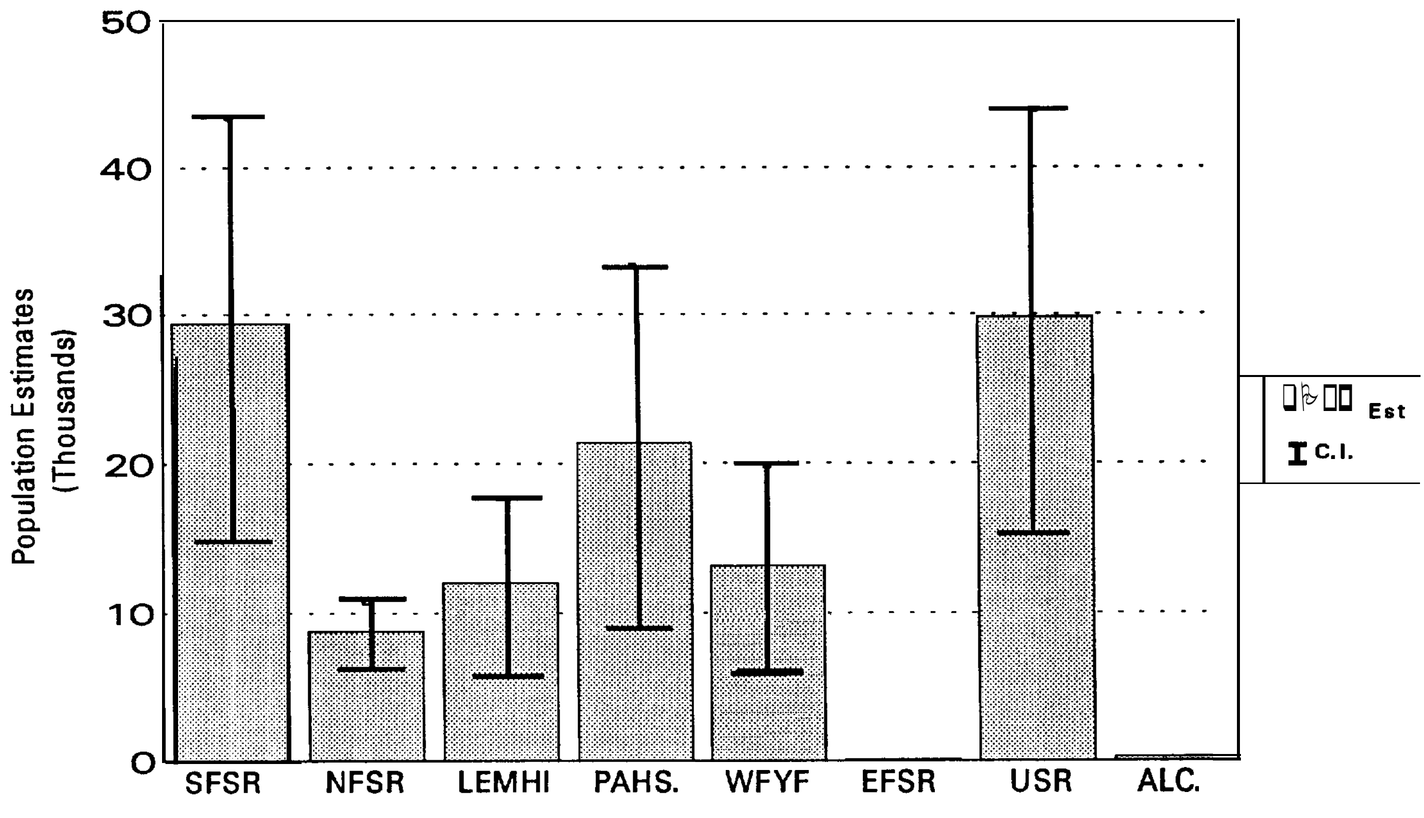


Figure 3. 1991 Chinook salmon parr population estimates for ISS study streams.

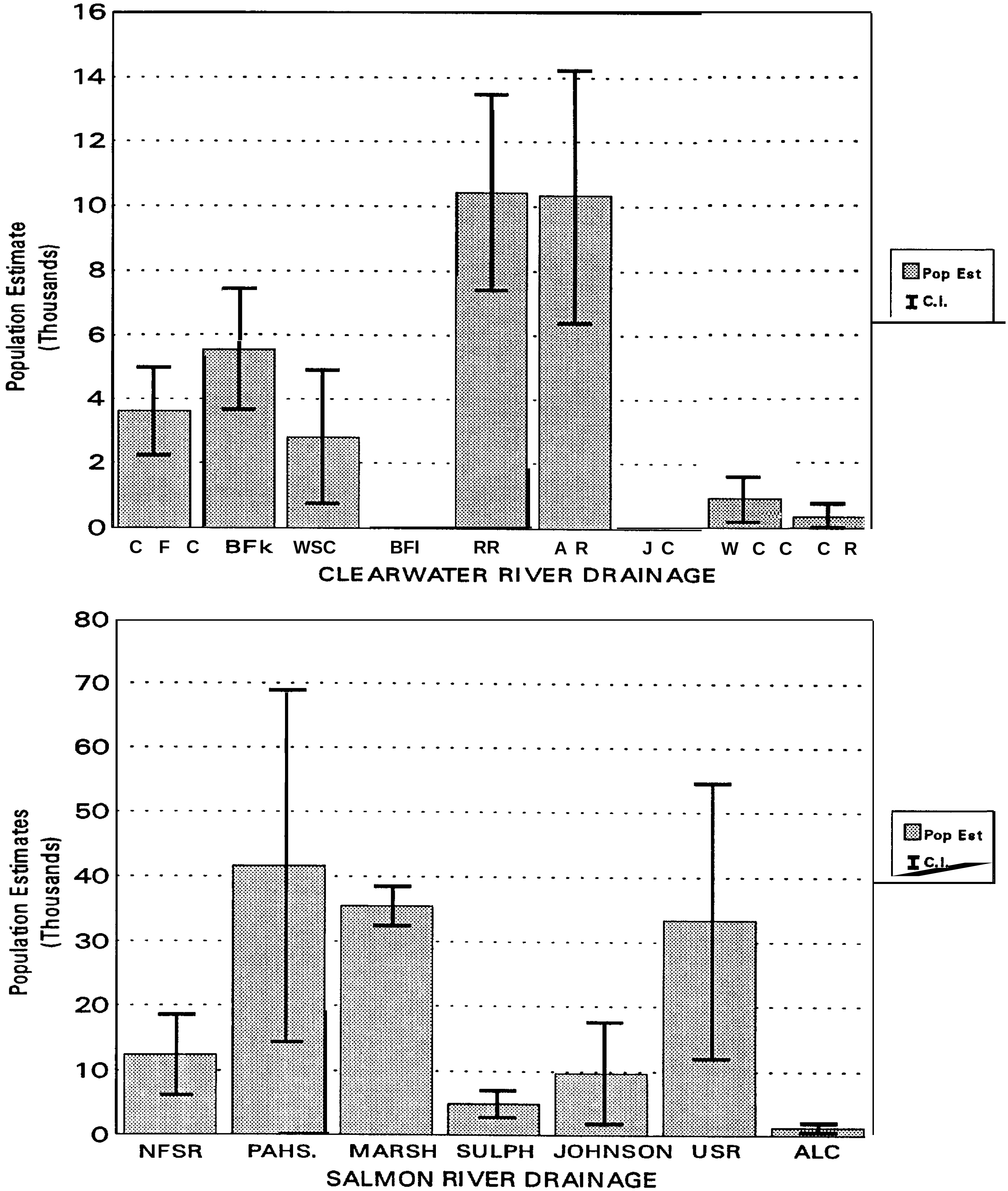


Figure 4. 1992 Chinook salmon parr population estimates for ISS study streams.

Table 3. ISS parr pit tagging summary, summer 1992.

TRIBUTARY	# TAGGED	# MORTALITIES (%)	# LOST TAGS (%)	# FISH RELEASED
NORTH FK. SALMON R.	517	2(0.4)	2(0.4)	513
PAHSIMEROI R.	492	9(1.8)	0	483
RED RIVER	312	18(5.8)	0	294
BRUSHY FK. CR.	230	13(5.7)	0	217
JOHNSON CR.	662	22(3.3)	0	640

Table 4. NMFS parr PIT tagging results, summer 1992. Steve Achord, NMFS, personal communication

TRIBUTARY	# TAGGED	# TAGGED MORTS	# RELEASED
BEAR VALLEY CREEK*	1017	2	1015
ELK CREEK*	628	0	628
EAST FK. SALMON R.*	843	2	841
HERD CREEK*	224	0	224
SOUTH FK. SALMON R.*	1004	4	1000
SECESH RIVER*	327	0	327
LAKE CREEK*	255	0	255
MARSH CREEK*	1000	0	1000
CAPE HORN CREEK	210	0	210
SULPHUR CREEK*	714	2	712
VALLEY CREEK*	1029	1	1028
CAMAS CREEK	1013	0	1013
LOON CREEK	261	0	261
UPPER BIG CREEK	451	0	451
LOWER BIG CREEK	282	0	282
RUSH CREEK	25	0	25
W.F. CHAMBERLAIN CREEK	498	2	496

• will be used for ISS

Table 5. Screw trap and pit tag results, fall 1992.

TRIBUTARY	TOTAL TRAP'D[a]	TOTAL TAG'D[b]	REL. AT TRAP	REL. ABV. TRAP	TRAP EFF. RECAP	TRAP EFF. (%)[c]	SUMMR RECAP	DWNSTRM RECAPS	OTHER RECAP	TRAP MORT #(%)	TAG MORT #(%)
CROOKED FK. CREEK *(WILD)* *(HATCHERY)*	1015 66	928 48	758 23	240 43	75 18	31.3 41.9	3 0	8 0	0 0	1(0.1) 0(0.0)	16(1.7) 0(0.0)
PAHSIMEROI RIVER *BOXT(WILD)* *SCREWT(WILD)* *SCREWT(HATCH)*	136 *493* 75	136 460 73	134 221 4	0 264 71	0 22 0	----- 6.6[d] -----	0 5 0	0 0 0	0 5 0	0(0.0) 1(0.2) 0(0.0)	2(1.5) 7(1.5) 0(0.0)
SOUTH FK. SALMON R.	875	696	253	621	140	22.5	36	3	0	0(0.0)	1(0.1)
RED RIVER *(WILD)* *(HATCHERY)*	*299* 136	272 0	250 135	48 0	8 0	15.4 0.0	5 0	10 0	4 31	0(0.0) 1(0.3)[e]	1(0.4) 0(0.0)

[a] calculated by adding; (fish released at the trap + fish released above the trap + total of all mortalities or by adding total tagged + total of all recaptures + trap mortalities).

[b] calculated by subtracting; (total of all recaptures + total of trap mortalities from the total number of fish trapped).

[c] calculated by dividing; (total number of recaptures for trap efficiency by number of fish released above the trap).

[d] both hatchery and wild fish released above trap were used to calculate trap efficiency.

[e] scarred and found dead in trap; not sure if scar was a wound, disease, or caused by trap.

Table 8. Trapping summary including incidental catches, fall 1992.

PAHSIMEROI RIVER. 9/14/92 - 12/9/92								
LENGTH FREQUENCY CHART (MM)	AGE 0 CHINOOK		INCIDENTAL CATCHES (NOT PIT TAGGED)					
	# TAGGED	# TRAPPED (INCLUDES ALL RECAP.)	STHD[1]	BK[2]	BT[3]	CT[4]	WF[5]	LR[6]
WILD (BOX)	136	136	NA	NA	NA	NA	NA	NA
WILD (SCREW)	460	493	NA	NA	NA	NA	NA	NA
HATCH (SCREW)	73	75	NA	NA	NA	NA	NA	NA
≤ 79	NA	NA	3	0	0	0	0	0
80-149	NA	NA	121	14	0	0	34	0
150-219	NA	NA	105	8	0	0	5	0
220-299	NA	NA	22	5	0	2	2	0
≥ 300	NA	NA	2	0	0	0	0	0

SOUTH FORK SALMON RIVER 9/15/92 - 11/5/92								
LENGTH FREQUENCY CHART (MM)	AGE 0 CHINOOK		INCIDENTAL CATCHES (NOT PIT TAGGED)					
	# TAGGED	# TRAPPED (INCLUDES ALL RECAP.)	STHD[1]	BK[2]	BT[3]	CT[4]	WF[5]	LR[6]
WILD	696	875	NA	NA	NA	NA	NA	NA
HATCHERY	0	0	NA	NA	NA	NA	NA	NA
≤ 79	NA	NA	33	1	0	0	0	0
80-149	NA	NA	123	23	0	0	3	0
150-219	NA	NA	63	23	6	1	1	0
220-299	NA	NA	1	2	0	0	12	0
≥ 300	NA	NA	0	0	0	0	27	0

[1] -STEELHEAD
[2] -BROOK TROUT
[3] -BULL TROUT
[4] -CUTTHROAT TROUT
[5] -WHITE FISH
[6] -LAMPREY

Table 6. Continued.

RED RIVER 9/18/92 - 10/27/92								
LENGTH FREQUENCY CHART (MM)	AGE 0 CHINOOK		INCIDENTAL CATCHES (NOT PIT TAGGED)					
	# TAGGED	# TRAPPED (INCLUDES ALL RECAP.)	STHD[1]	BK[2]	BT[3]	CT[4]	WF[5]	LR[6]
WILD	272	299	NA	NA	NA	NA	NA	NA
HATCHERY	0	136	NA	NA	NA	NA	NA	NA
≤ 79	NA	NA	3	0	0	0	4	0
80-149	NA	NA	55	55	0	1	111	2
150-219	NA	NA	92	38	0	3	73	0
220-299	NA	NA	10	7	1	6	214	0
≥ 300	NA	NA	0	2	0	0	9	0

CROOKED FORK CR. TRAPPING SUMMARY 9/18/92 - 11/10/92								
LENGTH FREQUENCY CHART (NM)	AGE 0 CHINOOK		INCIDENTAL CATCHES (NOT PIT TAGGED)					
	# TAGGED	# TRAPPED (INCLUDES ALL RECAP.)	STHD[1]	BK[2]	BT[3]	CT[4]	WF[5]	LR[6]
WILD	928	1015	NA	NA	NA	NA	NA	NA
HATCHERY	48	66	NA	NA	NA	NA	NA	NA
≤ 79	NA	NA	16	0	0	0	1	0
80-149	NA	NA	44	0	0	0	3	0
150-219	NA	NA	293	0	0	3	0	0
220-299	NA	NA	3	0	7	7	70	0
≥ 300	NA	NA	21	0	10	15	44	0

[1] -STEELHEAD
[2] -BROOK TROUT
[3] -BULL TROUT
[4] -CUTTHROAT TROUT
[5] -WHITE FISH
[6] -LAMPREY

Table 7. Estimates of outmigration during trapping period, fall 1992.

TRIBUTARY/STREAM	OUTMIGRANTS TRAPPED (MINUS TRAP EFF. RECAPS)	TRAP EFFICIENCY RECAPTURE[a]	TRAP EFFICIENCY	ESTIMATED OUTMIGRANTS[b]
CROOKED FORK CR. *(HATCHERY FISH)* *(WILD FISH)* 09/16 TO 11/10	48 *944*	18/43 75/240	41.9 31.3	126 3,016
RED RIVER *(HATCHERY FISH)* *(WILD FISH)* 09/18 TO 10/27	136 *291*	0/0 8/48	NOT ESTIMATED 16.7	NOT ESTIMATED 1,805
PAHSIMEROI RIVER *(BOX TRAP)* *(SCREW TRAP WILD)* *(SCREW TRAP HATCH)* 09/14 TO 12/09	136 471 75	22/335	6.6'	8,273
SOUTH FORK SALMON 09/15 TO 11/05	735	140/621	22.5	3,267

[a] the denominator represents the number of fish released above the trap, the numerator represents the number of those fish that were recaptured.

[b] calculated by dividing the number of tagged fish by trap efficiency.

[c] both hatchery fish and wild fish released above screw trap were used to calculate trap efficiency.

Variability associated with these estimates is high. Emigration occurred predominately at night and was highest following storm events and during dark lunar phases (figures 5 through 8).

Spawning Escapement

Weirs

Adult salmon were collected for broodstock at all IDFG hatchery weirs on ISS study streams. The numbers of adult chinook salmon trapped ranged from 18 at Red River in 1991 to 2,848 at the South Fork Salmon River weir in 1992. The number of salmon kept for broodstock ranged from zero at Crooked River (1991 and 1992) to 655 at the South Fork Salmon River weir during 1992. The numbers of salmon released to spawn ranged from seven in Red River in 1991 to 1,831 in the South Fork Salmon River during 1992 (Table 8).

The Marsh Creek weir was completed in mid-July. However, adults were not trapped this summer because water depth over the sill was too shallow to hold adult salmon. Also, it appeared that most of the adult salmon had moved above the weir site. Work is under way to modify the weir. We anticipate this work being completed in time for trapping the 1993 adult return.

Work is currently under way to obtain an access easement through private property on the North Fork Salmon River. The land owners seem amenable to an agreement but no price has been discussed. We are also pursuing the possibility of constructing the weir on a second location. This gives us an alternative in case an agreement cannot be reached on the initial site. Also, this should help expedite the easement process. The initial design and surveying work has been completed. The permitting process has begun.

We have written several letters to the district ranger, Cascade Ranger District of the USFS asking for input and assistance in the NEPA process for the proposed Johnson Creek weir. We will contact the USFS ISTAC representative to help facilitate and expedite this process.

Redd Counts

Redds were counted by ISS crews on three study streams during 1991 (Figure 9, Appendix D) and 19 study streams during 1992 (Figure 10, Appendix E). During 1992, redd counts in the Salmon River drainage ranged from a high of 66 in Marsh Creek (area covered was from the weir approx. 1/4 mi upstream of Cape Horn Creek to the headwaters) to a low of zero in Knapp, Whiskey, and Sand creeks. In the Clearwater River drainage, the redd counts ranged from a high of 44 in Red River to a low of two in White Cap Creek.

Broodstock Collection

During 1991, local broodstocks were collected for supplementation of existing natural populations at Powell, Red, upper Salmon, South Fork Salmon, East Fork Salmon, and Pahsimeroi rivers (Table 8). The hatchery and natural components of the run are not known. Also, progeny of hatchery broodstock collected at Rapid River Fish Hatchery were used for supplementation in areas without naturally reproducing chinook salmon populations (i.e. upper White Sand, Big Flat, and Squaw creeks [Table 9]). General production fish were used.

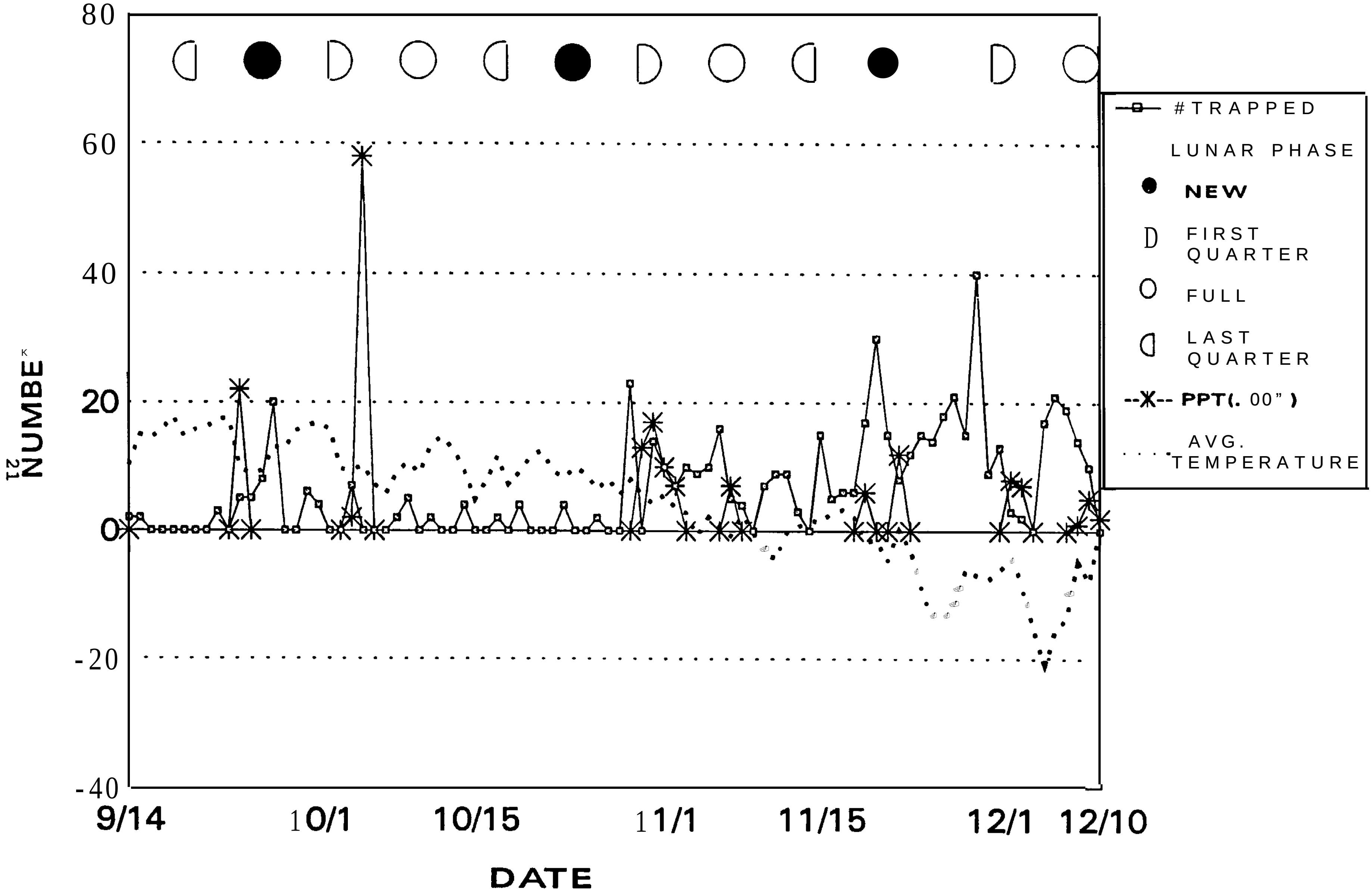


Figure 5. Daily trap results, lunar phase, precipitation, and average temperature for the Pahsimeroi River, fall 1992.

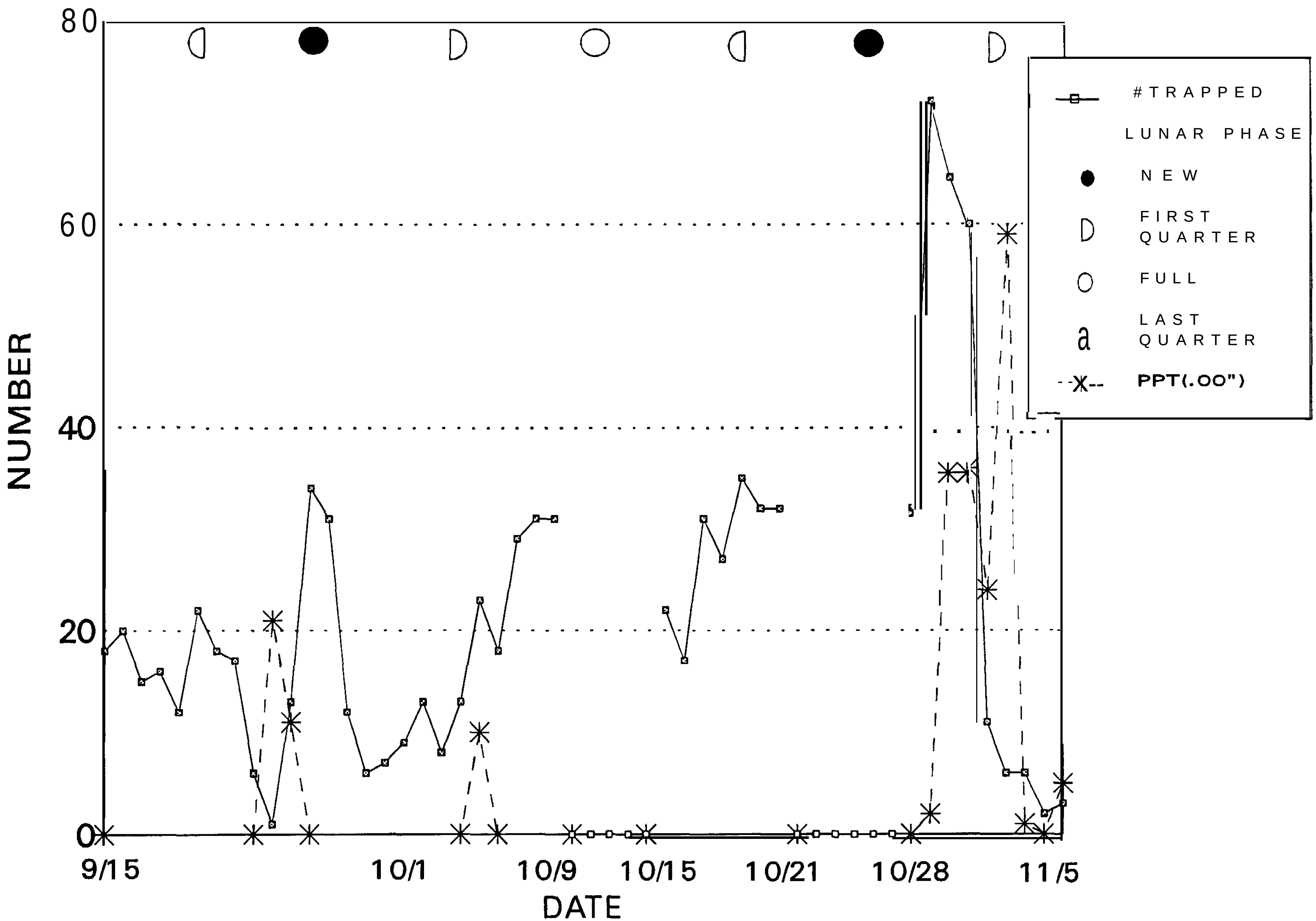


Figure 6. Daily trap results, lunar phase, and precipitation for the South Fork Salmon River, fall 1992.

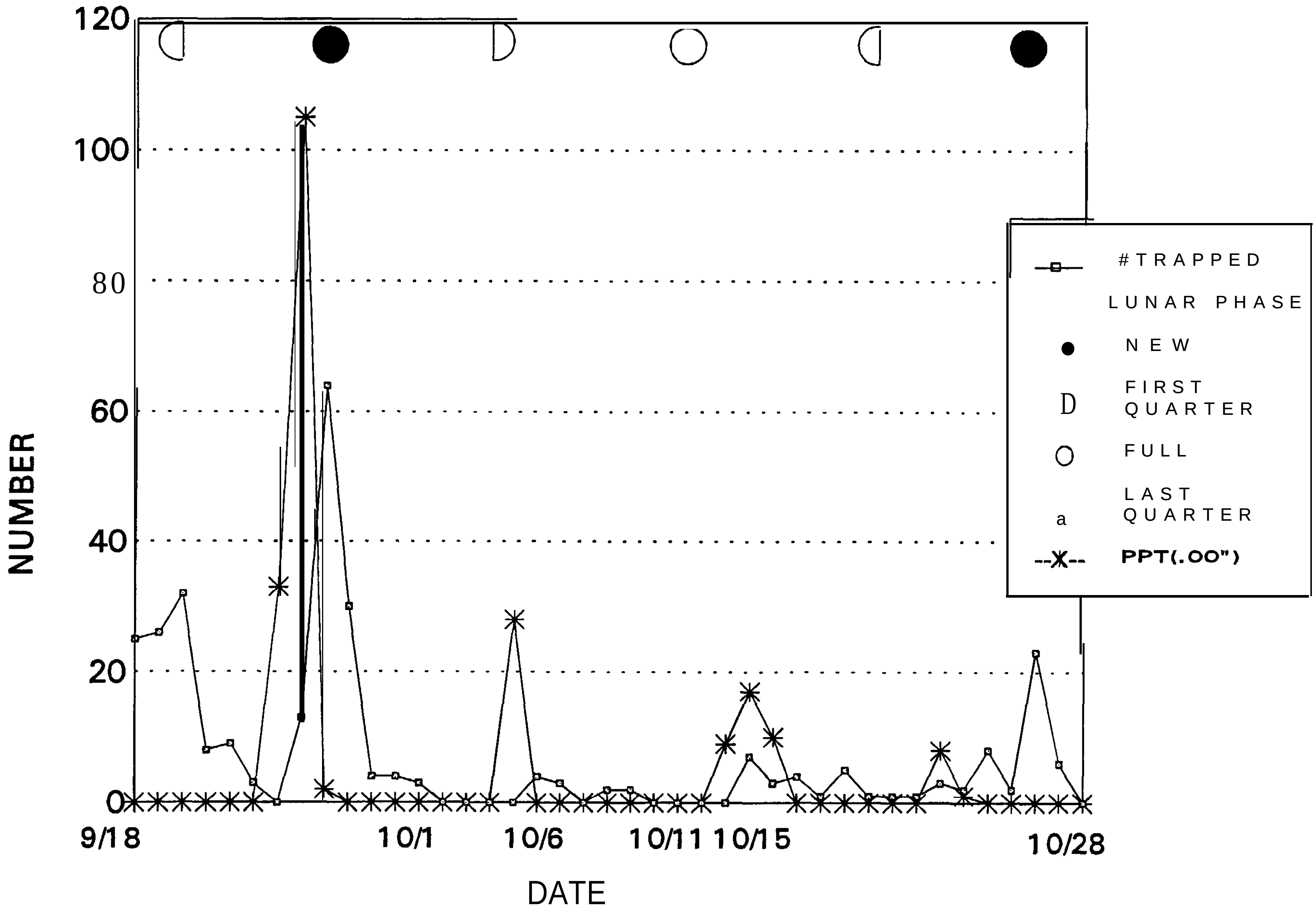


Figure 7. Daily trap results, lunar phase, and precipitation for Red River, fall 1992.

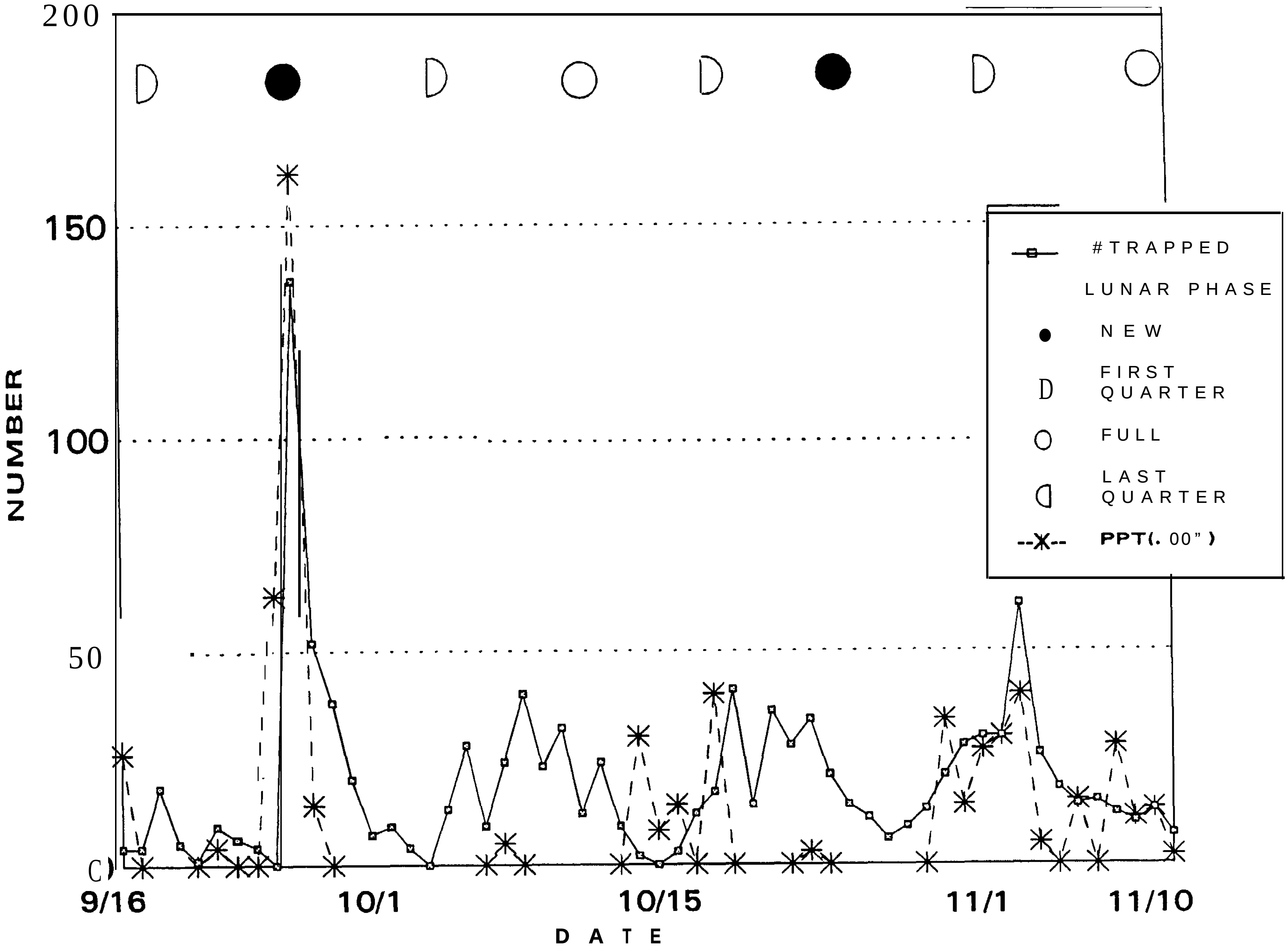


Figure 8. Daily trap results, lunar phase, and precipitation for Crooked Fork Creek, fall 1 992.

Table 8. Adult chinook salmon returns to IDFG hatchery weirs used with ISS.

YEAR	WEIR LOCATION	TOTAL TRAPPED	MALES TRAPPED	MALES SPAWNED	MALES RELEASED	MALE MORTS	OTHER	FEMALES TRAPPED	FEMALES SPAWNED	FEMALES RELEASED	FEMALE MORTS
1991	RED R.	18	11	6	4	1		7	3	3	1
	CROOKED R.	20	15	0	15	0		5	0	5	0
	POWELL	33	28	2	26	0		5	2	3	0
	SAWTOOTH	566	299	151[a]	144	4	11[*,b]	267	166	94	11
	E.F.S.R.	62	45	37	7	1		17	9	7	0
	S.F.S.R.	1,212	977	98	215	112	552[**]	235	138	73	24
	PAHSIMEROI	238	108	72	36	0		130	88	40	2
.992	RED R.	39	23	7	16	0		16	6	10	0
	CROOKED R.	228	134	0	126	8		94	0	90	4
	POWELL[c]	270	137	127	0	10		133	128	0	5
	SAWTOOTH	387	222	131	89	2		165	104	56	3
	E.F.S.R.	65	52	18	34	0		13	7	6	0
	S.F.S.R.	2,848	1,697	330	1,108	15		1,151	325	723	103
	PAHSIMEROI	131	77	49	25	3		54	35	18	1

*. 11 2 ocean males that were given to public or killed without spawning.
**. 552 jacks given to public or killed without spawning.
a. includes about 15 4 & 5 year old males spawned twice.
b. some of these were spawned.
c. weir was not installed, no broodstock collected for Crooked Fork Cr. supplementation.

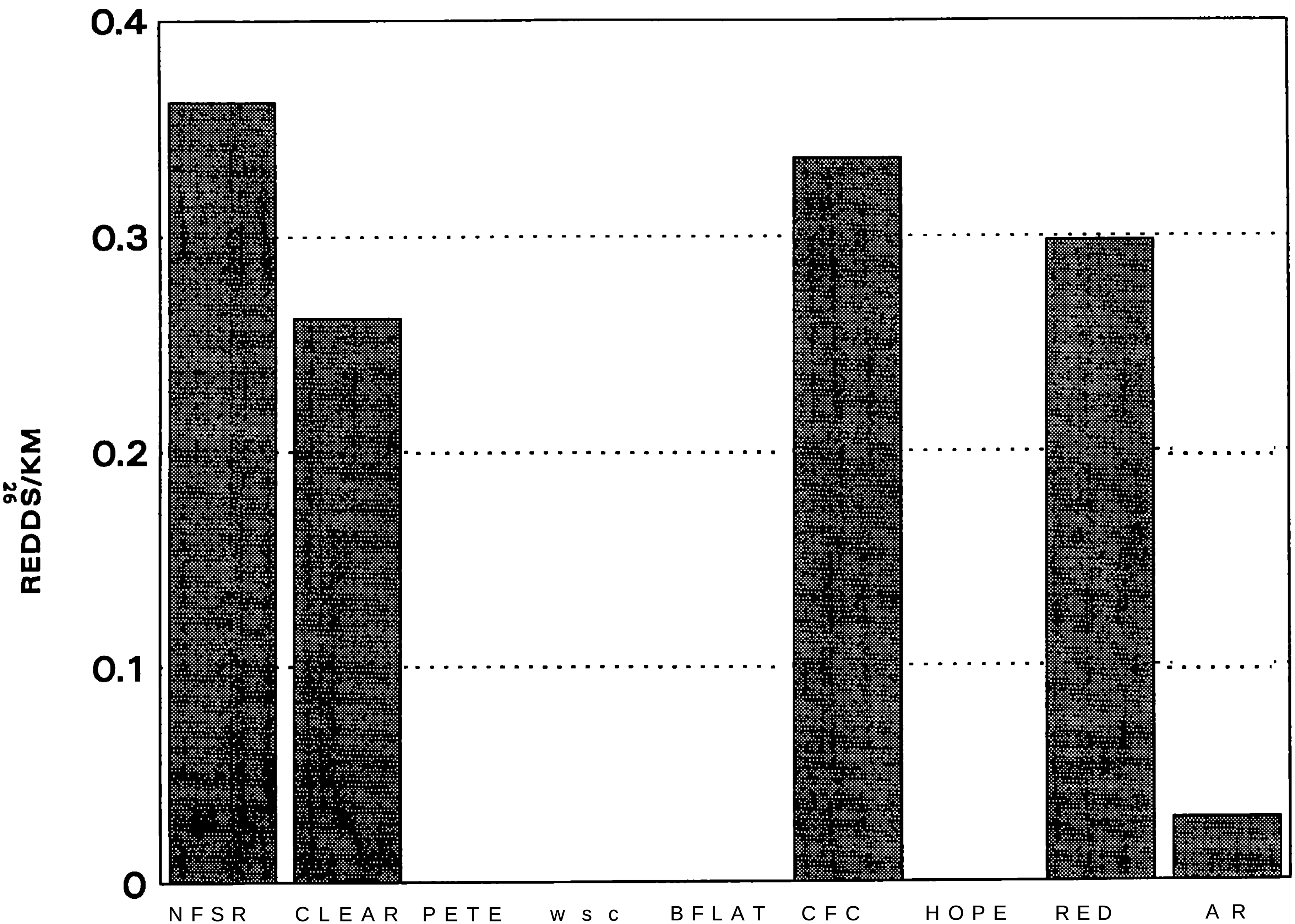


Figure 9. 1991 Chinook salmon redd counts in ISS study streams.

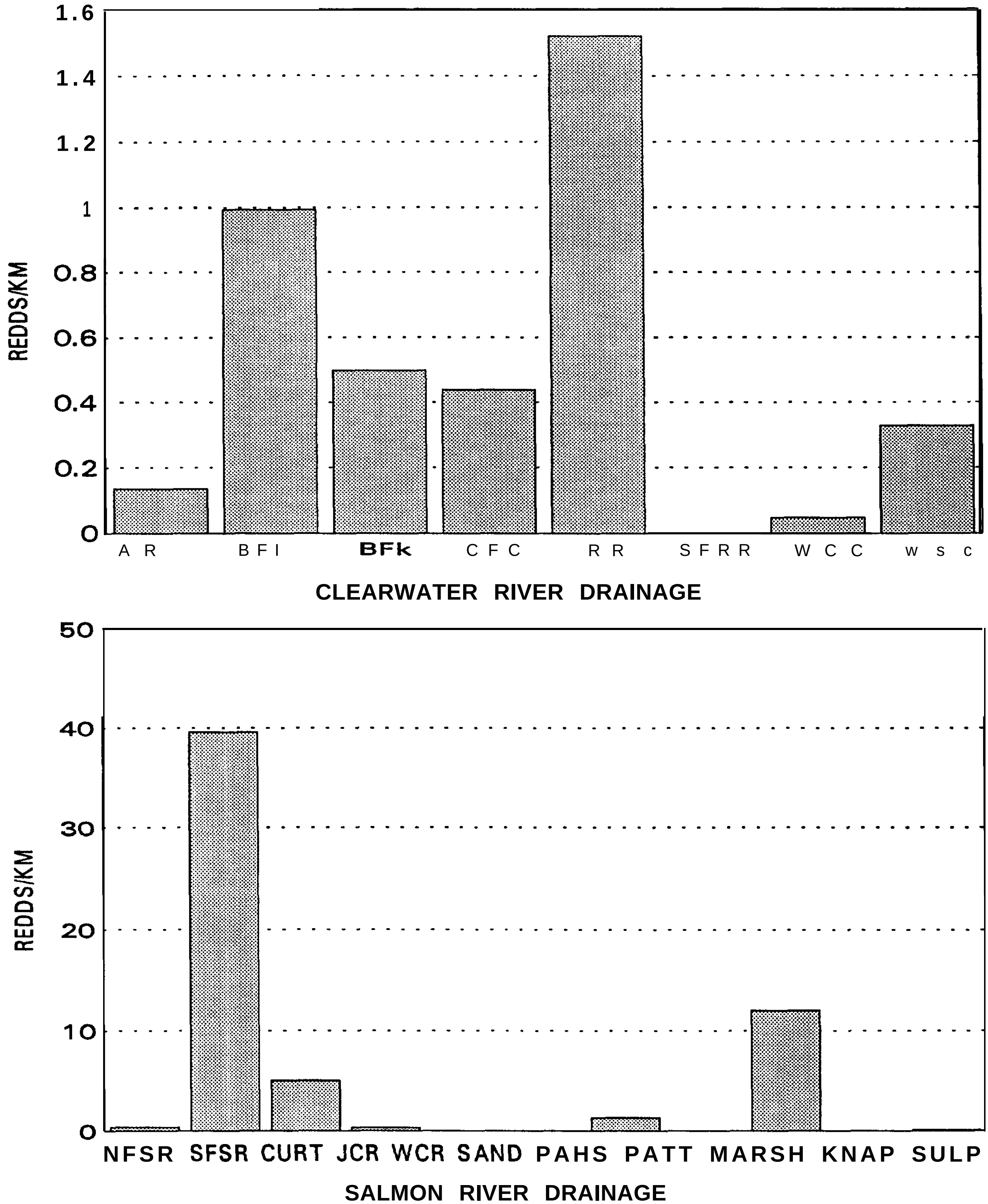


Figure 1 0. 1 992 Chinook salmon redd counts in ISS study streams.

Table 9. ISS related chinook salmon outplants 1992.

TRIBUTARY	NUMBER	LIFE STAGE	FIN CLIP NO.	FIN CLIP TYPE	NUMBER PIT TAGGED	RELEASE DATE	BROOD STOCK	REARING HATCHERY
SQUAW CREEK	10,000	PARR	10,000	RIGHT VENTRAL	700	07/16	RAPID R.	RAPID R.
WHITE SAND CREEK	90,000	PARR	90,000	RIGHT VENTRAL	1400	07/16	RAPID R.	RAPID R.
BIG FLAT CREEK	0	-----	0	-----	-----	-----	-----	--a---
CROOKED FK. CREEK	8,275	FALL PRESMOLT	8,275	LEFT VENTRAL	0'	09/04		CLEARWATER/ POWELL
RED RIVER	6,000	FALL PRESMOLT	6,000	LEFT VENTRAL	951	10/19		RED R.
UPPER SALMON (ABOVE WEIR)	200,000	FALL PRESMOLT	200,000	RIGHT VENTRAL	2100	10/02-10/07	SAWTOOTH	SAWTOOTH

* 48 Outmigrants PIT tagged at screw trap.

During 1992, local broodstocks were collected for supplementation of existing natural populations at Red, upper Salmon, South Fork Salmon, East Fork Salmon, and Pahsimeroi rivers and Clear Creek. Again, the hatchery and natural contributions were not known. Hatchery broodstocks collected at Powell will be used to supplement White Sand, Big Flat, Squaw, Pete King, and Papoose creeks.

Rearinq, Markinq, and Releases

Chinook salmon outplants into supplementation treatment streams during 1992 are summarized in Table 9. In July, a total of 100,000 parr from Rapid River Hatchery were released in restoration treatment streams in the upper Lochsa River drainage. Of these, Squaw Creek received 10,000 with 700 PIT tagged. The remaining 90,000 parr (with 1400 PIT tagged) were released by truck into White Sand Creek at the Colt Creek trailhead (approximately 7 km downstream of Big Flat Creek). All fish were right ventral fin clipped. We had planned to use a helicopter to release the 90,000 parr into upper White Sand Creek (60,000; above Big Flat Creek confluence) and Big Flat Creek (30,000). The helicopter flights were canceled due to heavy thunderstorm activity.

In early September, 8,275 fish were trucked from the Powell satellite facility to upper Crooked Fork Creek and released. These fish were progeny from four adults (two males and two females) collected at the Powell weir during 1991. None of these fish were PIT tagged, but all were right ventral fin clipped.1 n October, 6,000 fish were released directly from the Red River satellite facility into Red River. These fish were progeny from nine adults (three females and six males) collected at the Red River weir during 1991. All were right ventral fin clipped and 951 were PIT tagged. The fish were held for 3 d in the hatchery prior to release. No mortality of PIT tagged fish was observed.

During the week of October 2-7, approximately 200,000 fall presmolts were released upstream of Sawtooth Fish Hatchery. Roughly half were released above and half below the Busterback irrigation diversion. A total of 2,100 fish were PIT tagged. One low density (30,000), one medium density (60,000), and one high density (100,000) raceway from the Lower Snake River Compensation Plan's density study were used (700 PIT tags per raceway).

Dispersal and distribution of outplanted fish were monitored for several release groups by ICFWRU and IDFG personnel (Attachment A).

DISCUSSION

Parr Abundance and PIT Tassinq

Only two streams in the Salmon River drainage (North Fork Salmon and Pahsimeroi rivers) were snorkeled in both 1991 and 1992 by IDFG's ISS crews. The 1992 estimates for both cases were approximately 42% and 94% higher than 1991, but the differences were not statistically detectable ($P > 0.1$). Four streams in the Clearwater River drainage were snorkeled both years. The population increased in two of the streams (American River, $P < 0.1$; and White Sand Creek, $P > 0.1$), decreased in one (Crooked Fork Creek, $P < 0.1$), and remained the same in the other (Big Flat Creek population was zero both years).

The ISS experimental design calls for confidence intervals within 30% of the chinook salmon estimate (coefficient of variation = 23%) to maintain enough power to detect expected supplementation effects (Bowles and Leitzinger 1991). We have reached this in only two cases in 1991 (North Fork Salmon River 24%; and Clear Creek 29%) and two cases in 1992 (Marsh Creek 8%; and Red River; 29%). Other error bounds have ranged as high as 124% of the point estimate (Pete King Creek, 1991). There are two main reasons for this. First, in many cases, there are too few sample sites. Second, the low seeding levels we are presently observing result in a very high variation in the number of juveniles counted. Counts vary with proximity to a redd. We hope to rectify this problem this next field season by increasing the number of sites, incorporating number of redds and redd location as covariates, and calculating population estimates by habitat type.

We met our summer parr PIT tagging target (500 fish per stream) in 40% of the study streams. Densities of chinook salmon parr were too low to warrant PIT tagging in several streams snorkeled by IDFG ISS crews. PIT tagging mortality was quite low. The fish were kept in live wells for 24 h after tagging before being released into the stream. There were only two instances where PIT tagging mortalities were above 5%. This was most likely a temperature related problem. We observed increases in mortality as water temperatures approached 20°C. Protocols are now in place to stop PIT tagging when water temperatures exceed 15°C.

Fall Emigrants and PIT Tagging

Fall outmigration during 1992 appeared to be related to storm events (and associated declines in water temperature) and lunar phase. When storm events coincided with the new moon, the number of juvenile chinook salmon trapped increased dramatically. In the following years, we will continue to evaluate the association between these cues and outmigration. Hopefully, this information will help improve the success of supplementation releases. Other researchers (Hopkins 1991) have found increased survival to adult of chinook salmon smolts released just prior to the new moon.

Trap efficiencies were relatively high for all traps except the Pahsimeroi River (efficiency estimate = 6.6%). This low trap efficiency may be due to the stream characteristics. The Pahsimeroi River is a low elevation, low gradient, relatively warm and deep spring fed stream. It is a much less harsh environment than the high elevation batholith streams. This also explains the later outmigration timing for these fish. We speculate that some of the trapped fish released above the trap (to estimate trap efficiency): 1) did not continue their migration; 2) moved at a much slower rate, thus passed the trap site after the trap was removed; or 3) moved at a later date.

Overall, the screw traps functioned well with low chinook salmon mortality (<0.4%) and good efficiency (7-42%). There appeared to be no size or species selectivity. But, there was significant wear on parts of the trap. The traps are being modified to avoid this unnecessary wear in the future. Spring emigrant trapping is scheduled to begin in early March, 1993. This should be in time to trap the entire spring outmigration.

We met our fall emigrant PIT tag target (500 fish per stream) in two out of the four streams. PIT tag mortality was low (<2%). We do not anticipate major changes in operations during 1993, although the Marsh Creek trap will be motorized, and the site will be modified (rock weir) to increase water depth approximately 30 cm at the weir to trap adult chinook salmon.

Spawning Escapement

Weirs

Most of the existing weirs operated well during 1991 and 1992. The Marsh Creek weir was not completed in time to trap any adult salmon, plus water was too shallow at the weir site had the weir been completed earlier.

The loss of the Powell weir resulted in the inability to collect broodstock for Crooked Fork Creek in 1992. The 1993 plans are to use a temporary weir in Crooked Fork Creek above the mouth of Brushy Fork Creek to collect broodstock for supplementation in Crooked Fork Creek.

Redd Counts

Only one stream was counted by IDFG ISS crews in both 1991 and 1992 (North Fork Salmon River). There was an increase in redds between years. This reflects the greater number of adults passing Lower Granite Dam in 1992.

Redds were counted in Big Flat Creek in 1992. No adult chinook salmon, naturally produced juvenile chinook salmon, or redds have been seen in Big Flat Creek in recent history. These adults were likely the result of fry outplants in the late 1980s.

We began our redd counts in mid-September. As a result, not all the streams could be counted three times during the spawning period. However, because the counts were late, we were able to observe late spawning chinook salmon in most streams. For example, live female chinook salmon were seen on new redds in the Pahsimeroi River as late as October 25. This late arriving group of fish seemed to be typical of most of the streams, and would have gone unnoticed using a single count just after peak spawning. Although common in 1992, we do not know if this was a year - effect or typical spawning behavior.

Broodstock Collection

Although at a reduced scale, broodstock collections for supplementation followed the ISS Experimental Design quite well. The main limitation to full implementation of the Design is broodstock availability resulting from low adult returns to Idaho. Broodstock was severely limited for restoration streams in the Clearwater River drainage during 1991, but improved dramatically in 1992. Broodstock for augmentation streams (i.e. streams with existing natural populations) in the Clearwater River and Salmon River drainages was severely limited during 1991 and 1992. Allocations for supplementation are based on percentages for these streams, thus supplementation plans are proceeding but at very low levels.

Rearina. Marking, and Releases

Fish husbandry, marking and releases of supplementation fish went smoothly during initial implementation of the supplementation program. Weather caused adjustments in two releases. Parr planned for release in upper White Sand Creek and Big Flat Creek were released at an access point farther down the drainage because the weather was too severe for helicopter releases. Better contingency plans for helicopter releases will be developed to avoid this constraint in the future. Smolt releases into the upper Salmon River were planned for April, 1993.

Low water conditions and a severe icing threat at Sawtooth Fish Hatchery forced presmolt releases to occur during October, 1992. Enough supplementation fish are being held over winter at Sawtooth Fish Hatchery to allow us to evaluate both the presmolt and smolt releases.

CONCLUSIONS

Overall, the first intensive field season went well. Some of the weaknesses and problems should be taken care of prior to the next field season.

Some interesting observations were made. The late arriving chinook salmon spawners in most streams needs to be monitored to see if it was just a result of a low flow year or normal for those streams. Outmigration cues need to be analyzed for relationships between environmental cues and chinook salmon outmigration. This information could help plan stocking to maximize survival of outmigrating hatchery chinook salmon.

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A P P E N D I C E S

Appendix A. Standardized snorkeling techniques to be used in Idaho Supplementation Studies.

Methods:

- The number of snorkelers depends on visibility and width of the stream.

- Snorkelers move slowly but steadily upstream in an assigned lane. The widths of the lanes are determined by visibility. The snorkelers are not in a single line perpendicular to the stream. Instead, they are staggered. For example, if there are five snorkelers, one snorkeler will be close to each bank and counting fish between themselves and the banks. The next two divers will be slightly downstream (l-3 m depending on visibility) and closer to the center of the stream. They count the fish that swim between themselves and the diver closest to the bank on their side. The final diver is in the middle of the stream downstream of the other four and counts all the fish the swim between the two divers and swim past them. In essence, the divers form a "V" in the stream. It is important that they maintain proper positioning in their respective lanes in order to maintain accuracy of the counts.

- Field crews are trained prior to each field season in snorkeling techniques, fish identification, and size estimation. Calibrated dowels are carried by novices for more accurate size estimation.

- Visibility is measured prior to snorkeling (with an orange and white nylon measuring tape held underwater) to insure that visibility is sufficient to allow accurate counts. In most streams, visibility is >3 m.

- Snorkeling is done in daylight hours, after streams temperatures have risen above 8°C. Juvenile salmonids have shown to conceal themselves when water temperatures drop to or below this level (Hillman et. al. in press; Reihle 1990).

- Chinook salmon are identified and counted as YOY, yearlings, or adults. All other salmonids are identified and lengths are estimated to the nearest inch. After several fish have been counted by an individual, he tells the data recorder walking on the bank behind the snorkelers. The recorder draws detailed sketch maps of the snorkeling reach, noting major habitat types, easily recognizable features of the surrounding land, etc. This person also gives detailed directions to the site, the starting and ending points, presence of flagging, and any other information that may be of value in locating the sites in the future. If a recorder is not available, all is recorded on plexiglass slates carried by the divers.

Appendix B. ISS part population estimates and chinook densities, summer 1991. The numbers in parentheses represent the error bound as a percent of the population estimate.

SALMON RIVER DRAINAGE

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP.EST.	90% C.I.
SOUTH FK. SALMON R.	3 (WEIR TO WARM LAKE TURNOFF)	13	27,563	14,447	26.94	1,700	689	343	169
SOUTH FK. SALMON R.	2 (WARM LAKE TURNOFF TO RICE CR.)	10	1,799	1,965	1.55	24	24	8	10
SOUTH FK. SALMON R.	1 (RICE CR. TO HEADWATERS)	1	0	0	0	0	0	0	0
TOTAL	ALL STRATA	24	29,362	14,080 (47.95)	11.33	1,724	667	351	164
NORTH FK. SALMON R.	3 (MOUTH TO HUGHES CR.)	9	2,153	1,313	1.59	4,499	1,030	2,169	539
NORTH FK. SALMON R.	2 (HUGHES CR. TO JOHNSON GULCH)	14	6,570	1,698	4.94	6,731	1,353	2,675	529
NORTH FK. SALMON R.	1 (JOHNSON GULCH TO HEADWATERS)	14	0	0	0	1,399	444	1,884	551
TOTAL	ALL STRATA	37	8,723	2,052 (23.52)	2.40	12,629	1,682	6,728	895
LEMHI R.[A]	1 (FROM COTTAM LN TO LEADORE)	9	10,675	5,870	3.16	5,182	2,198	4,448	2,920
	BIG SPRINGS CR. INCLUDED (ONLY 1 STRATA)	12	1,347	1,105	2.47	8,182	5,119	94	64
TOTAL	ALL STRATA & TRIBS	21	12,022	5,683 (47.27)	3.59	13,364	5,408	4,542	2,776

Appendix B. cont.

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
PAHSIMEROI R.	1 (WEIR TO DIXON RANCH)	20	21,396	11,837	10.38	3,955	2,242	3,085	958
TOTAL	ALL STRATA	20	21,396	11,837 (55.32)	10.38	3,955	2,242	3,085	958
WEST FK. YANKEE FK.	1 (MOUTH TO HEADWATERS)	18	13,179	6,654	8.80	347	176	218	144
TOTAL	ALL STRATA	18	13,179	6,654 (50.49)	8.80	347	176	218	144
EAST FK. SALMON R.	2 (WICKIUP CR. TO BOWERY CR.)	6	0	0	.08	6,648	3,620	239	207
EAST FK. SALMON R.	1 (WEIR TO WICKIUP CR.)	5	78	116	0	467	641	387	312
TOTAL	ALL STRATA	11	78	105 (134.62)	.04	7,115	3,441	626	342
UPPER SALMON RIVER	10(UPSTREAM 6,200 M. FROM TOP OF STRATA 9)	3	0	0	0	23	42	69	127
UPPER SALMON RIVER	9 (UPSTREAM 6,200 M. FROM TOP OF STRATA 8)	2	0	0	0	41	125	27	82

Appendix B. cont.

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
UPPER SALMON RIVER	8 (UPSTREAM 4,500 M. FROM TOP OF STRATA 7)	2	0	0	0	0	0	0	0
UPPER SALMON RIVER	8 (SIDE CHANNEL)	2	0	0	0	15	44	15	44
UPPER SALMON RIVER	7 (UPSTREAM 7,000 M. FROM TOP OF STRATA 6)	2	60	182	.14	323	242	182	60
UPPER SALMON RIVER	7 (SIDE CHANNEL)	2	0	0	0	35	106	12	34
UPPER SALMON RIVER	6 & 5 COMBINED (5700 M U.S. FROM TOP OF STRATA 4)	4	67	105	.04	42	41	0	0
UPPER SALMON RIVER	6 SIDE CHANNEL & 5 SIDE CHANNEL COMBINED	2	0	0	0	0	0	0	0
UPPER SALMON RIVER	4 & 3 COMBINED (13,200 M U.S. FROM TOP OF STR. 2	7	9,100	7,220	2.16	235	209	160	125
UPPER SALMON RIVER	4 SIDE CHANNEL & 3 SIDE CHANNEL COMBINED	3	1,760	1,614	5.25	40	73	42	46
SMILEY CREEK	2(UPSTREAM 2,400 METERS FROM 1(TOP)	5	60	85	.32	0	0	0	0

Appendix B. cont.

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
SMILEY CREEK	1 (FROM MOUTH UPSTREAM 2,100 M.)	4	0	0	0	25	40	0	0
POLE CREEK	5 (U.S. 2,400 M. FROM TOP OF 4)	2	0	0	0	0	0	0	0
POLE CREEK	4 (U.S. 4,100 M. FROM TOP OF 3)	2	0	0	0	0	0	0	0
POLE CREEK	3 (U.S. 2,700 M. FROM TOP OF 2)	7	800	536	5.76	28	29	0	0
POLE CREEK	2 (U.S. 3,200 M. FROM TOP OF 1)	2	24	73	.13	131	40	24	73
POLE CREEK	1 (FROM MOUTH U.S. 2,100 M.)	2	0	0	0	14	40	8	23
PETIT LAKE CREEK AND YELLOW-BELLY CR. COMBINED	P.L.C. = 1 STRATA (FROM MOUTH TO BRG U.S. 1,700 M.) Y.C. = 1 STRATA (FROM MOUTH U.S. 1,200 METERS)	3	0	0	0	69	46	108	46
HUCKLE-BERRY CR.	2 (1,300 METERS U.S FROM 1(TOP)	2	7	19	.16	20	58	13	39
HUCKLE-BERRY CR.	1 (FROM MOUTH TO DECKER FLAT RD.)	2	5	12	.23	0	0	8	21
GOLD CR.	2 (1,500 METERS U.S. FROM 1(TOP)	2	0	0	0	0	0	0	0
GOLD CR.	1 (FROM MOUTH U.S. 1,300 M.)	2	582	1,647	26.35	0	0	0	0

Appendix B. cont.

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
FRENCHMAN CREEK	2 (5,600 METERS U.S. FROM 1(TOP)	5	17,331	14,668	88.70	0	0	0	0
FRENCHMAN CREEK	1 (FROM MOUTH U.S. 1,100 M.)	2	8	22	.26	0	0	0	0
CHAMPION CREEK	2 (3,000 METERS U.S. FROM 1(TOP)	2	0	0	0	0	0	0	0
FOURTH OF JULY CR.	2 (5,200 METERS U.S. FROM 1(TOP)	2	0	0	0	116	177	0	0
FOURTH OF JULY CR.	1 (FROM MOUTH U.S. 3,400 M.)	2	0	0	0	151	109	46	136
BEAVER CREEK	2 (3,800 METERS U.S. FROM 1(TOP)	2	0	0	0	0	0	0	0
BEAVER CREEK	1 (FROM MOUTH U.S. 2,700 M.)	2	0	0	0	44	133	0	0
TOTAL	ALL STRATA & TRIBS	81	29,804	14,102[B]	2.61	1,352	N/A[B]	714	N/A[B]
ALTURAS LK. CREEK	3 (2,000 METERS U.S. FROM 2(TOP)	2	0	0	0	0	0	0	0
ALTURAS LK. CREEK	2 (1,800 METERS U.S. FROM 1(TOP)	2	0	0	0	0	0	0	0
ALTURAS LK. CREEK	1 (FROM MOUTH U.S. 2,400 M.)	3	266	261	.36	15	26	0	0
TOTAL	ALL STRATA	7	266	244[B]	.21	15	N/A[B]	0	0

ppendix B. cont.

CLEARWATER RIVER DRAINAGE									
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
AMERICAN R.	3 (MOUTH TO BOX SING CR.	12	266	139	[illegible]	3,866	952	2,550	716
AMERICAN R.	2 (BOX SING CR. TO UNNAMED TRIB.)	13	2,600	1,299	2.03	3,698	849	2,799	772
AMERICAN R.	1 (UNNAMED TRIB. TO HEADWATERS)	10	1,691	1,249	4.29	433	185	736	249
TOTAL	ALL STRATA	35	4,557	1,826 (40.07)	1.79	7,997	1,239	6,093	1,100
NEWSOME CREEK	1 (MOUTH TO NEWSOME TOWN)	14	5,692	1,969	5.66	6,081	1,729	2,054	359
TOTAL	ALL STRATA	14	5,692	1,969 (34.59)	5.66	6,081	1,729	2,054	359
CLEAR CR.	2 (MOUTH TO U.S. F.S. BOUNDARY)	17	25,311	7,372	21.25	12,779	3,023	1,644	575
CLEAR CR. INCLUDING CLEAR CR. SOUTH FK.	1 (U.S.F.S BOUNDARY TO HEADWATERS)	3	0	0	0	17,991	7,105	3,674	483
TOTAL	ALL STRATA	20	25,311	7,333 (28.97)	18.39	30,770	5,843	5318	665
PETE KING CREEK	1 (MOUTH TO END OF THE ROAD)	9	1,569	1,942	3.24	3,194	1,422	762	328
TOTAL	ALL STRATA	9	1,569	1,942 (123.77)	3.24	3,194	1,422	762	328

Appendix B. cont.

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
CROOKED FORK CR.	4 (MOUTH TO BRUSHY FK.CR.)	13	5,812	1,886	2.16	9,554	2,352	5,694	1,927
CROOKED FORK CR.	3 (BRUSHY FK. CR. TO BOULDER CR.)	9	1,316	681	.89	432	298	320	187
CROOKED FORK CR.	2 (BOULDER CR. TO HOPEFUL CR.)	3	6,176	9,613	6.27	482	104	241	303
TOTAL	ALL STRATA	25	13,304	7,009 (52.68)	1.89	10,468	2,310	6,255	1,897
BIG FLAT CREEK	1 (MOUTH TO HEADWATERS)	5	0	0	0	4,208	2,124	425	453
TOTAL	ALL STRATA	5	0	0 (0)	0	4,208	2,124	425	453
WHITE SAND CR.	1 (BIG FLAT CR. TO HEATHER CR.)	10	1,910	1,220	1.83	1,941	666	453	286
TOTAL	ALL STRATA	10	1,910	1,220 (63.87)	1.83	1,941	666	453	286
CROOKED RIVER	4 (FROM TOP OF 3 TO CANYON SECT)	3	0	0	0	1,756	847	39	44
CROOKED RIVER	3 (FROM MOUTH TO MEANDER SECT.)	3	0	0	0	922	154	50	23
CROOKED RIVER	2 (FROM TOP OF CANYON TO CRKD. RIVER RD BRIDGE)	4	0	0	0	2,957	1,968	143	124

Appendix B. cont.

TRIBUTAR	1 RATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
CROOKED RIVER	1 1 (FROM TOP OF 2 TO 400 YDS. U.S. FROM 5 MILE CR.)	6	O	0	O	260	133	32	22
CROOKED RIVER	CANYON SECT.)					2,405	824	210	148
CROOKED RIVER CROOKED RIVER	CANYON HEADWATERS (ALL STRATA OF	3 5	0 0	0 0	0 0	44	42	27	41
CROOKED RIVER	POND A - STRATA	2	0	0	0	38	74	2	4
CROOKED RIVER	POND B - STRATA	3	0	0	0	323	538	42	40
RELIEF CREEK	2 (FROM TOP OF 1 TO CONFL. OF E. FK. & W. FK.)	2	0	0	0	124	84	13	37
RELIEF CREEK	1 (FROM MOUTH U.S. 250 M.)	2	0	0	0	267	536	40	77
TOTAL	ALL STRATA & TRIBS	33	0	O (O)	0	9096	N/A	598	N/A
RED R.									
RED R.	LITTLE MOOSE CR. RD.								
	R. 3D (DAWSON (SOUTH FK. CR. RED TO R. TO RED R. CAMPGROUND	20 94	6,285 1,602	2,127 8,114	8.37 7.69	287 196	381 253	733 180	239 946
TOTAL	ALL STRATA	114	7,887	10,166 (128.89)	8.20	483	623	913	1,177

[A] = Based on electrofishing population estimates.

[B] = Alturus Lake Creek and the Upper Salmon River (including it's tributaries) population estimates are from Russell Kiefer's population estimates.

Appendix C. ISS parr population estimates and chinook salmon densities, summer 1992. The number in parentheses represents the error bound as a percent of the population estimate.

SALMON RIVER DRAINAGE									
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
NORTH FK. SALMON R.	3 (MOUTH TO HUGHES CR.)	9	358	210	.28	353	115	339	199
	2 (HUGHES CR. TO JOHNSON GULCH)	17	11,957	6,183	8.84	2,557	706	1,583	401
	1 (JOHNSON GULCH TO HEADWATERS)	14	113	151	.13	810	565	365	132
TOTAL	ALL STRATA	40	12,428	6,044 (48.63)	3.75	3,720	886	2,287	452
PAHSIMEROI R.		20							
TOTPAHSIMEROI	1 (MOUTH TO HOOPER LN.)	20	41,600	27,279	19.11	3,105	1,237	5,850	2,017
	ALL STRATA		41,600	27,279 (65.57)	19.11	3,105	1,237	5,850	2,017

	CR.)								
MARSH KNAPP CR. CR.	2 1 1 (MOUTH (WEIR (KNAPP TO TO CR. KNAPP TO HEADWATERS)	22 10 10	29,063 4,928 1,439	3,059 476 213	22.06 3.53 7.41	595 126 514	250 515 78	147 118 76	87 68 73
	HEADWATERS)								
TOTAL	ALL STRATA & TRIBS	42	35,430	2,925 (8.26)	20.51	1,235	549	341	126

Appendix C. cont.

SALMON RIVER DRAINAGE									
TRIBUTARY	**STRATA** (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
SULPHUR CR.	2 (MOUTH TO CONF. OF SULPHUR CR. & NORTH FK. SULPHUR CR.)	22	3,703	1,706	2.60	62	55	0	0
	1 (CONF. TO HEADWATERS)	7	1,144	973	2.29	74	105	0	0
TOTAL	ALL STRATA	29	4,847	1,913 (39.47)	2.62	136	110	0	0
JOHNSON CR.	4 (MOUTH TO DEADHORSE RAPIDS)	3	149	264	.56	69	122	52	92
	3 (DEADHORSE RAPIDS TO WHITEHORSE RAPIDS)	10	8,870	8,189	3.80	280	261	139	101
	2 (WHITEHORSE RAPIDS TO BURNT LOG TRAIL CROSSING)	3	0	0	0	893	1,062	2,545	1,660
	1 (BURNT LOG TRAIL CROSSING TO HEADWATERS)	21	729	769	.46	101	79	42	38
SAND CR.	1 (MOUTH TO HEADWATERS)	1	0	0	0	0	0	0	0
ROCK CR.	1 (MOUTH TO HEADWATERS)	1	0	0	0	0	0	0	0
TOTAL	ALL STRATA & TRIBS	39	9,748	7,773 (79.74)	1.68	1,343	784	2,778	1,156

ppendix C. cont.

3ALMON RIVER DRAINAGE

CRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELBEAD AGE 1 POP. EST.	90% C.I.	STEELBEAD AGE 2 POP. EST.	90% C.I.
JPPER SALMON RIVER	3 (SAWTOOTH WEIR TO ROCKY MNT. RANCH)	5	9,327	13,828	6.50	399	727	30	54
	3 (SIDE CHANNEL)	2	1,677	7,006	25.20	7	44	0	0
	4 (ROCKY MNT. RANCH UPSTREAM 8500 M)	6	7,181	12,898	.96	7	21	24	73
	4 (SIDE CHANNEL)	2	4,257	26,457	28.46	0	0	24	149
	5 (TOP OF 4 UPSTREAM 2900 M)	2	459	125	.81	0	0	0	0
	6 (TOP OF 5 UPSTREAM 2800 M)	2	0	0	0	0	0	0	0
	7 (TOP OF 6 UPSTREAM 7000 M)	2	94	282	.04	0	0	0	0
	7 (SIDE CHANNEL)	1	55	339	2.76	0	0	0	0
	8 (TOP OF 7 UPSTREAM 4500 M)	2	44	132	.05	0	0	0	0
	8 (SIDE CHANNEL)	2	22	133	.18	0	0	0	0
	9 (TOP OF 8 UPSTREAM 6200 M)	2	0	0	0	0	0	172	520
	10 (TOP OF 9 UPSTREAM 6200 M)	3	0	0	0	0	0	41	75
SMILEY CREEK	1 (MOUTH TO BRIDGE)	4	0	0	0	0	0	0	0
	2 (BRIDGE UPSTRREAM 7500 M)	2	0	0	0	0	0	0	0
POLE CREEK	1 (MOUTH TO BARN)	2	0	0	0	63	14	0	0
	2 (BARN TO DIVERSION)	2	0	0	0	51	15	0	0
	3 (DIVERSION TO RAINBOW CR. ROAD)	2	0	0	0	0	0	0	0
	4 (RAINBOW CR. ROAD UPSTREAM 4100 M)	2	0	0	0	0	0	73	219
	5 (4 UPSTREAM 1300 M)	2	0	0	0	0	0	0	0

Appendix C. cont.

SALMON RIVER DRAINAGE									
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
YELLOWBELLY CREEK	1 (MOUTH TO ROCK SLIDE)	1	197	0	1.27	0	0	16	0
HUCKLEBERRY CREEK	1 (MOUTH TO DECKER FLAT ROAD)	2	58	8	2.40	0	0	0	0
GOLD CREEK	1 (MOUTH UPSTREAM 2800 M)	2	0	0	0	0	0	0	0
FRENCHMAN CREEK	1 (MOUTH UPSTREAM 1100 M)	2	0	0	0	0	0	0	0
	2 (TOP OF 1 UPSTREAM 5600 M)	5	14,485	15,516	91.17	0	0	0	0
FORTH OF JULY CREEK	1 (MOUTH UPSTREAM 8600 M)	2	643	1,276	3.33	23	69	106	238
CHAMPION CREEK	1 (MOUTH UPSTREAM 5500 M)	2	0	0	0	0	0	0	0
BEAVER CREEK	1 (MOUTH UPSTREAM 3400 M)	1	0	0	0	0	0	0	0
	2 (TOP OF 1 UPSTREAM 3000 M)	2	0	0	0	0	0	0	0
PETIT LAKE CREEK	1 (MOUTH TO BRIDGE)	2	873	1,013	7.33	0	0	0	0
TOTAL	ALL STRATA & TRIBS	61	33,361	21,077 (63.18)	4.42				

Appendix C. cont.

SALMON RIVER DRAINAGE										
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
ALTURUS LAKE CREEK	1 (MOUTH TO PETIT LAKE ROAD)	4	10	9	.05	0	0	12	9
	2 (ROAD UPSTREAM 1800m)	5	92	42	.72	0	0	7	12
	3 (TOP OF 2 TO DIVERSION)	3	922	393	6.36	20	36	0	0
	4 (DIVERSION TO PETIT LAKE)	2	207	628	.15	0	0	0	0
	5 (PETIT LAKE TO JAKES GULCH)	2	0	0	0	0	0	0	0
TOTALS	ALL STRATUM & TRIBS	16	1,231	522 (42.40)	1.13	20		19	

Appendix C. cont.

CLEARWATER DRAINAGE									
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
CROOKED FK. CR.	4 (MOUTH TO BRUSHY FK.)	13	2,444	1,068	.89	1,052	554	1,068	591
	3 (BRUSHY FK. TO BOULDER CR.)	9	1,109	890	.73	204	101	190	207
	2 (BOULDER CR. TO HOPEFUL CR.)	5	69	105	.08	172	262	171	127
	1 (HOPEFUL CR. TO HEADWATERS)	3	0	0	0	0	0	0	0
HOPEFUL CR.	1 (MOUTH TO HEADWATERS)	3	0	0	0	39	73	0	0
TOTAL	ALL *STRATA* & TRIBS	33	3,622	1,333 (36.80)	.47	1,467	591	1,429	614
BRUSHY FK. CR.	5 (MOUTH TO PACK CR.)	3	239	281	.28	505	255	314	382
	4 (PACK CR. TO TWIN CR.)	7	3,718	1,831	6.12	1,821	369	890	480
	3 (TWIN CR. TO SPRUCE CR.)	14	1,588	703	4.74	904	147	312	54
SPRUCE CR.	1 (MOUTH TO HEADWATERS)	2	0	0	0	5,989	8,948	4,143	7,327
TOTAL	ALL *STRATA* & TRIBS	26	5,545	1,825 (32.91)	4.49	9,219	3,862	5,659	3,191
WHITE SAND CR.	1 (BIG FLAT CR. TO HEADWATERS)	18	2,795	2,032	2.80	508	236	170	121
TOTAL	ALL STRATA	18	2,795	2,032 (72.70)	2.80	508	236	170	121

Appendix C. cont.

CLEARWATER DRAINAGE

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELBEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
BIG FLAT CR.	1 (MOUTH TO HEADWATERS)	12	0	0	0	65	59	100	98
TOTAL	**ALL STRATA**	**12**	**0**	**0 (0)**	**0**	**65**	**59**	**100**	**98**
RED R.	6 (MOUTH TO GOLD PT.)	0	0	0	0	0	0	0	0
	5 (GOLD PT. DAWSON CR.)	3	0	0	0	0	0	1,191	---
	4 (DAWSON CR. TO LITTLE MOOSE CR. RD.)	3	4,503	1,404	15.01	107	103	3,175	1,245
	3 (LITTLE MOOSE CR. RD. TO SOUTH FK. RED R.)	2	2,620	6,543	7.94	50	152	76	229
	2 (SOUTH FK. RED R. TO RED R. CAMPGROUND.)	50	2,789	795	3.61	1,242	182	410	87
	1 (RED R. CAMPGROUND TO HEADWATERS)	4	505	736	.82	400	374	32	52
TOTAL	ALL STRATA	62	10,417	2,984 (28.65)	5.17	1,799	362	4,884	152

Appendix C. cont.

CLEARWATER DRAINAGE

TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELHEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
AMERICAN R.	3 (MOUTH TO BOX SING CR.)	11	495	290	.45	2,797	1,192	523	265
	2 (BOX SING CR. TO UNNAMED TRIB.)	14	7,763	3,864	6.10	473	385	279	159
	1 (UNNAMED TRIB. TO HEADWATERS)	8	2,072	1,055	5.79	216	152	169	97
TOTAL	ALL STRATA	33	10,330	3,885 (36.61)	3.52	3,486	1,206	971	310
JOHNS CR.	1 (MOUTH TO HEADWATERS)	7	0	0	0	12,429	3,822	5,481	2,153
TWIN LAKES CR.	1 (MOUTH TO HEADWATERS)	5	0	0	0	523	20	72	219
MOORE CR.	1 (MOUTH TO HEADWATERS)	2	0	0	0	0	0	0	0
GOSPEL CR.	1 (MOUTH TO HEADWATERS)	1	0	0	0	3,813	---	1,794	0
TOTAL	AI& STRATA & TRIBS	15	0	0 (0)	0	16,755	3,617	7,347	2,041
WHITE CAP CR.	3 (MOUTH TO JUST BELOW CANYON CR.)	3	0	0	0	1,251	802	813	596
	2 (JUST BELOW CANYON CR. TO BARRIER)	6	892	688	.58	3,286	926	1,758	549
CANYON CR.	1 (MOUTH TO HEADWATERS)	1	0	0	0	0	0	0	0
TOTAL	ALL STRATA & TRIBS	10	892	660 (73.99)	.15	4,531	1,073	2,571	690

Appendix C. cont.

CLEARWATER DRAINAGE									
TRIBUTARY	STRATA (FROM - TO)	# SECTIONS	CHINOOK POP. EST.	90% C.I.	#/100m2	STEELBEAD AGE 1 POP. EST.	90% C.I.	STEELHEAD AGE 2 POP. EST.	90% C.I.
CROOKED RIVER	3 (MOUTH TO MEANDER)	3	36	65	.11	3,675	973	671	78
	4 (MEANDER TO CANYON)	3	32	57	.08	3,749	1,208	546	42
	CANYON (ALL OF CANYON)	3	29	53	.04	4,861	649	1,263	371
	2 (TOP OF CANYON TO CROOKED R. BRIDGE)	4	236	183	.56	3,833	1,688	762	280
	HBADWATERS (CRCXBCED R. BRIDGE TO W. FK)	5	0	0	0	55	82	16	24
	1 (TOP OF 2 400 YDS.)	6	0	0	0	1,118	360	218	147
	POND A	3	9	9	.35	103	72	36	24
	POND B	3	0	0	0	1,669	832	169	157
FIVE MILE	1 (MOUTH UP STREAM 250 METERS)	2	0	0	0	3	7	0	0
RELIEF CR.	2 (BRIDGE TO HEADWATERS)	2	0	0	0	497	611	72	311
	1 (MOUTH TO BRIDGE)	2	74	40	1.71	517	907	154	120
TOTAL	ALL STRATA & TRIBS	34	416	548 (131.73)	.19	20,080	26,489	3,907	5,153

Appendix D. ISS redd/carcass summary, fall 1991.

REDD/CARCASS COUNTS CHINOOK SUPPLEMENTATION RESEARCH									
TYPE OF COUNT	STREAM	DATES	# REDDS	START	END	# LIVE FISH ♂	# LIVE FISH ♀	FL(MM) # CARCASSES ♂	FL(MM) # CARCASSES ♀
GROUND	NORTH FK. SALMON R.	9/9	8	HWY 93 BRIDGE IMMEDIATELY SOUTH OF THE TOWN OF NORTH FK.	USFS BOUNDARY UPSTREAM OF GIBBONSVILLE	0	2'	860	820 880
GROUND	CLEAR CR.	9/16-9/17	4	KOOSKIA HATCHERY WEIR	USFS BOUNDARY	1[b]	1' 1[d]	840" 530• 770' 760 800 860 914	
GROUND	PETE KING CR.	9/17	0	MOUTH	WALDE CR.	0	0	0	0

Appendix D. Cont. Regional Redd Counts, Fall 1991.

AERIAL	WHITE SAND CR.		0	MOUTH	BIG FLAT CR.	0	0	0	0
AERIAL	BIG FLAT CR.		0			0	0	0	0
AERIAL	CROOKED FK. CR.		10	MOUTH	HOPEFUL CR.	0	0	0	0
AERIAL	HOPEFUL CR.		0	MOUTH	HEADWATERS	0	0	0	0
AERIAL	BEAR CR.		8	MOUTH	CUB CR.	0	0	0	0
AERIAL	BEAR CR.		2	CUB CR.	HEADWATERS	0	0	0	0
AERIAL	SELWAY R.		2	MOUTH	GEDNEY CR. (FALLS)	0	0	0	0
AERIAL	SELWAY R.		4	FALLS	BEAR CR.	0	0	0	0
AERIAL	SELWAY R.		5	BEAR CR.	WHITE CAP CR.	0	0	0	0
AERIAL	SELWAY R.		1	WHITE CAP CR.	LITTLE CLEARWATER	0	0	0	0
AERIAL	SELWAY R.		6	LITTLE CLEARWATER	MAGRUDER CROSSING	0	0	0	0
AERIAL	SELWAY R.		23	TRADITIONAL AREAS	TRADITIONAL AREAS	0	0	0	0
AERIAL	MIDDLE SELWAY R.		18	INCLUDED IN TRADITIONAL AREAS	INCLUDED IN TRADITIONAL AREAS	0	0	0	0
AERIAL	RED R.		6	MOUTH	WEIR	0	0	0	0
AERIAL	AMERICAN R.		1	MOUTH	HEADWATERS	0	0	0	0
AERIAL	NEWSOME CR.		0	MOUTH	HEADWATERS	0	0	0	0
AERIAL	LOCHSA R.		6	MOUTH	HEADWATERS	0	0	0	0
GROUND	LOLO CR.		11	MOUTH	HEADWATERS	0	0	0	0

[a] 24" - 34"
[b] > 35"
[c] 24" - 34"
[d] > 35"
. theme fish were not spawned

Appendix E. Salmon and Clearwater river Chinook redd count summary, 1992.

SALMON RIVER DRAINAGE

TRIBUTARY	COUNT METHOD	DATE	# RBDDS	START MWEREND	STOP UPPER END	MALE (mm)	FEMALE (mm)
NORTH FORK SALMON RIVER	GROUND	09/09/92 09/11/92	7[a]	MOUTH	UPPER END ELK MEADOWS RANCH		710 860 840 710
	GROUND	10/27/92 10/28/92	5	MOUTH	UPPER END ELK MEADOWS RANCH		
TOTALS			12				4@780

SOUTH FORK SALMON RIVER	GROUND	08/07/92 09/05/92	446	WEIR	VULCAN HOT SPRINGS TRAIL		
TOTALS			446			418770	181@780

CURTIS CREEK	GROUND		8[b]	MOUTH	1 MILE ABOVE MOUTH		
TOTALS			8				

JOHNSON CREEK	GROUND	09/15/92 09/22/92	8	BURNT LOG TRAIL	HEADWATERS	840 740	810 730 810 840 710
	GROUND	09/30/92 10/06/92	0	BURNT LOG TRAIL	HEADWATERS		
	GROUND	10/16/92 10/20/92	3	BURNT LOG TRAIL	HEADWATERS		
TOTALS			11			2@790	5@780

Appendix E. cont'd.

SALMON RIVER DRAINAGE							
WHISKEY CREEK	GROUND	10/16/92 10/20/92	0	MOUTH	1 MI.ABOVE MOUTH		
TOTALS							

SAND CREEK	GROUND	10/16/92 10/20/92	0	MOUTH	1 MI.ABOVE MOUTH		
TOTALS			0				

PAHSIMEROI RIVER	GROUND	10/10/92 10/30/92	0 0	MOUTH	WEIR		
	GROUND	09/12/92 10/06/92 10/11/92	1[c] 1 0	WEIR	P4 SCREEN	760 720 720 830 780	
	GROUND	10/03/92 10/14/92 10/25/92	2[d] 0 4	P4 SCREEN	P7 SCREEN		
	GROUND	10/02/92 10/13/92 10/25/92	2 0 2	P7 SCREEN	REARING PONDS		
	GROUND	10/02/92 10/13/92 10/24/92	7" 0 0	REARING PONDS	DOWTON LN.		
	GROUND	09/23/92 10/06/92 10/24/92	6 7 0	DOWTON LN.	PATTERSON CREEK		
	GROUND	09/20/92	0	PATTERSON CR.	HOOPER LN.		
	GROUND	10/05/92	0	HOOPER LN.	UPSTRM. 3 MI.		
TOTALS			32			5@762	

SALMON RIVER DRAINAGE

PATTERSON CREEK	GROUND	09/12	0	MOUTH	HOOPER LN.		
TOTALS			**0**				

KARSH CREEK	GROUND	08/18/92	42"	MOUTH CAPE HORN CREEK	MOUTH KNAPP CREEK	770 880 660 690 870 670 870 760 680 810 680 850 760	790 660 950 760 700 870 750 710 710 960 780 740 730
	GROUND	10/20/92 10/21/92	24	MOUTH CAPE HORN CREEK	MOUTH KNAPP CREEK		
TOTALS			66			**13@765**	**13@778**

KNAPP CREEK	GROUND	08/19/92	0	MOUTH	END ASHER CR. RD.		
	GROUND	09/10/92 09/12/92	0	MOUTH	END ASHER CR. ROAD		
TOTALS			0				

SULPHUR	GROUND	09/10/92 09/12/92	1	MOUTH	WEST FORK SULPHUR		
TOTAL			**1**				

[a] (2) two ocean males, and (1) unknown were viewed.

[b] (1) two ocean male, (2) three ocean males, and (2) three ocean females,

[c] (2) three ocean males, and (2) three ocean females were viewed.

[d] (1) two ocean female was viewed.

[e] (5) two males, (5) three ocean males, (7) two ocean females, (4) three ocean females, (1) unknown female, (1) two ocean unknown, and (2)jacks were viewed.

Appendix E. cont'd.

CLEARWATER RIVER DRAINAGE							
TRIBUTARY	COUNT METHOD	DATE	# REDDS	START LOWER END	STOP UPPER END	MALE (mm)	FEMALE (mm)
AMERICAN RIVER	GROUND	10/05/92	2	MOUTH	MOTHER LODE RD.		
	GROUND	10/06/92	3	MOTHER LODE RD.	FLAT IRON ROAD		
	GROUND	10/10/92 10/12/92	0	FLAT IRON RIDGE ROAD	AMERICAN RIVER CAMPGROUND		
	GROUND	10/19/92 10/20/92	0	AMERICAN RIVER CAMPGROUND	PRIV. PROP. BELOW SPRING CREEK		
TOTALS			5[a]				
BIG FLAT CR.	GROUND	09/28/92 10/01/92	8	MOUTH	5 MILES ABOVE CONFLUENCE		
TOTALS			8				
BRUSHY FORK CREEK	GROUND	09/27/92 10/03/92	6	MOUTH	BRIDGE ON ELK MEADOWS ROAD		
	GROUND	10/21/92 10/24/92	1	MOUTH	MIGRTN. BARRIER ABV. SPRUCE CR.		
TOTALS			7[b]				
CROOKED FORK CREEK	GROUND	09/27/92 10/03/92	9	MOUTH	BRIDGE ON HWY. 12	780	720
	GROUND	10/04/92 10/07/92	4	BRIDGE ON HWY. 12	HOPEFUL CREEK	710	700
	GROUND	10/14/92 10/17/92	0	MOUTH	HOPEFUL CREEK		860
TOTALS			13			28745	38760

Appendix E. cont'd.

CLEARWATER RIVER DRAINAGE

RED RIVER	GROUND	10/14/92 10/15/92	9[c]	MOUTH	USFS ROAD 1180		660 670
	GROUND	10/03/92	10	USFS ROAD 1180	DAWSON CREEK		620 700
	GROUND	09/30/92 10/02/92	15	DAWSON CREEK	MOOSE BUTTE ROAD	850 710	670 720
	GROUND	09/22/92	10	MOOSE BUTTE ROAD	WEIR	710 720	810 680
	GROUND	09/19/92 09/21/21	0	WEIR	MOUTH OF SCHISSLER CREEK		730 690
TOTALS			44			48748	10[illegible]695

S.FK.RED R.	GROUND	10/01/92	0	MOUTH	TRAPPER CREEK		
TOTALS			0				

WHITE CAP CREEK	GROUND	09/22/92 09/25/92	2[d]	MOUTH	HEADWATERS		
TOTALS			2				

Appendix E. cont'd.

CLEARWATER RIVER DRAINAGE							
WHITE SAND CREEK	GROUND	09/28/92 10/01/92	3	MOUTH BIG FLAT CREEK	HEAD WATERS		
	GROUND	09/28/92 10/01/92	0	MOUTH	3 MILES ABOVE MOUTH		
	GROUND	10/25/92 10/26/92	0	3 MILES ABOVE MOUTH	7 MILES ABOVE MOUTH		
TOTALS			3				

[a] (0) new redds were seen.

[b] (1) new redd was seen in addition to the (6) old redds.

[c] (1) two ocean female, and (1)jack were viewed.

[d] (1) two ocean male prespawn mort, possibly diseased.

Appendix F. Abbreviated stream names used in Figures 3, 4, 9, and 10.

AR - American River
BFL - Big Flat Creek
BFK - Brushy Fork Creek
CFC - Crooked Fork Creek
RR - Red River
SFRR - South Fork Red River
WCC - White Cap Creek
WSC - White Sand Creek
NFSR - North Fork Salmon River
SFSR - South Fork Salmon River
CURT - Curtis Creek
JCR - Johnson Creek
WCR - Whiskey Creek
SAND - Sand Creek
PARS - Pahsimeroi River
PATT - Patterson Creek
MARSH - Marsh Creek
KNAP - Knapp Creek
SULP - Sulphur Creek
NCR - Newsome Creek
CCR - Clear Creek
PKC - Pete King Creek
CR - Crooked River
LEMHI - Lemhi River
WFYF - West Fork Yankee Fork
EFSR - East Fork Salmon River
USR - Upper Salmon River
ALC - Alturus Lake Creek

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1992 Annual Report

ECOLOGICAL EFFECTS OF HATCHERY REARED CHINOOK SALMON ON NATURALLY PRODUCED CHINOOK SALMON

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for

Idaho Supplementation Studies
Small-scale Studies
Idaho Department of Fish and Game

and

Bonneville Power Administration
Portland, Oregon

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Abstract

This is the first annual report for small-scale studies associated with the Idaho Supplementation Studies (ISS) project. The goal of ISS small scale studies is to evaluate risks and benefits of using supplementation strategies to enhance natural production of chinook salmon populations in Idaho rivers and streams. We investigated the interactions possible between hatchery and natural chinook salmon at different densities and sizes through experimental trials run in an artificial stream. We found very few statistically significant differences between the behavior of hatchery and natural chinook salmon at different sizes or densities. In general the hatchery fish tended to move out of the artificial stream sections in higher numbers, to be more active (less reclusive), to use less cover habitat, and to be more aggressive than the natural chinook salmon. But more replication is needed before conclusions can be drawn.

The number and type of experiments run were greatly limited by low numbers of natural chinook salmon collected from the Lemhi River. We estimated the number of chinook salmon juveniles moving downstream past the Lemhi River weir during the fall of 1991 and all of 1992 to be in the range of 25,000 fish, drastically reduced from previously reported numbers. A partial count of 33 adult chinook salmon were passed over the Lemhi River weir in the fall of 1992. More chinook salmon adults were expected to have moved upstream before the weir was closed. There was no significant difference in the survival or travel times to Lower Granite Dam of PIT tagged chinook salmon released at the headwaters versus at the mouth of the Lemhi River. Hatchery chinook salmon released into Squaw Creek in July, 1992 remained about one km downstream of the release site until October when water temperatures dropped, after which they were found throughout the creek downstream from the release site. A total of 786 chinook salmon were collected from 12 streams and two hatcheries in 1992 and sent to establish a genetic database of Idaho natural and hatchery chinook salmon populations.

Introduction

The use of hatchery production to supplement natural anadromous **salmonid** populations in the Columbia River Basin has increased over the last few decades in an attempt to compensate for the decline of these stocks. The continued reduction of natural **salmonid** populations despite the release of millions of hatchery smolts annually has raised question as to the effectiveness of our current hatchery production and stocking techniques. The success of any supplementation project depends on several factors; the condition and character (behavior) of the hatchery fish at the time of release, the stocking technique used, the condition of the receiving waters, and the interactions with resident fish populations. Of special concern is the effect hatchery fish will have on the naturally-produced **salmonid** populations following release. It has become a high priority within Idaho and the Columbia River Basin to assess the benefits and risks associated with using hatcheries to enhance **naturally-**reproducing salmon and steelhead populations. These efforts are necessary to determine the relative utility of supplementation as a recovery tool for anadromous stocks.

The goal of the Idaho Supplementation Studies (ISS) is to "assess the use of hatchery chinook salmon to restore or augment natural populations, and to evaluate the effects of supplementation on the survival and fitness of existing natural populations" (Bowles and Leitzinger 1991). Ultimately supplementation should lead to self-sustaining and harvestable populations of salmon and steelhead in Idaho waters, and eventually reduce the need for hatchery production.

Towards this goal, the Idaho Supplementation Studies has been designed incorporating three levels of investigation. The first two levels are the large-scale population productivity studies and the evaluation of specific supplementation strategies in study streams throughout the state over several chinook salmon generations (12-15 years). The third level of investigation is the small-scale studies to investigate specific questions regarding the techniques and effects of supplementation on hatchery and naturally produced chinook salmon productivity and on the potential interactions between hatchery and natural fish in Idaho streams. In this report we summarize the initial field season (1992) of an ISS small-scale study conducted by the Idaho Cooperative Fish and Wildlife Research Unit (ICFWRU), University of Idaho, Moscow, on the Lemhi River in East Central Idaho. We also summarize results from **ICFWRU's** component of the large-scale studies associated with the ISS.

During 1992, we investigated the interactions that occur between hatchery and naturally-produced chinook salmon in controlled experiments, and how these interactions may influence the productivity of both groups of fish. The types of interactions possible between hatchery and natural chinook salmon include competition for space, competition for food, and aggressive encounters (Steward and Bjornn 1990). These interactions can potentially lead to modifications in the migration behavior, growth rates, reproductive success, and genetic makeup of the natural populations. The main questions addressed during this study involved how the size and density of fish at time of stocking influenced the hatchery/natural interactions and productivity.

Our component of the ISS large-scale studies during 1992 included: monitoring the movement of adult and juvenile chinook salmon and estimating the chinook salmon parr population size in the Lemhi River, Idaho; investigating the survival of PIT tagged chinook salmon juveniles from the Lemhi River to Lower Granite Dam; determining the dispersion rate of hatchery chinook salmon parr released into Squaw Creek, upper Lochsa River; and the collection of chinook salmon smolts and pre-smolts from 12 Idaho streams and two hatcheries to establish a genetic database of these populations.

Objectives

Small-scale studies

1. Determine if hatchery-produced juvenile chinook salmon successfully disperse, survive, and grow following release into infertile Idaho streams.

2. Determine the importance of size and density of hatchery fish at time of release on the interactions between hatchery and naturally-produced chinook salmon.

3. Determine if resident trout, particularly brook trout, reduce the productivity of released hatchery chinook salmon.

4. Determine relative survival benefits to Lower Granite Dam for naturally-produced chinook salmon smolts released at lower, mid, and upper Lemhi River sites.

Larse-scale study component

5. Determine the extent and magnitude of chinook salmon juvenile downstream movement past the Lemhi River weir.

6. To PIT tag 1,800 chinook salmon juveniles at the Lemhi River weir for detection at Lower Granite Dam.

7. Determine the adult chinook salmon escapement to the Lemhi River weir.

8. Collect juvenile chinook salmon from Idaho streams and hatcheries for electrophoresis analysis to be used to establish a genetic database of these populations.

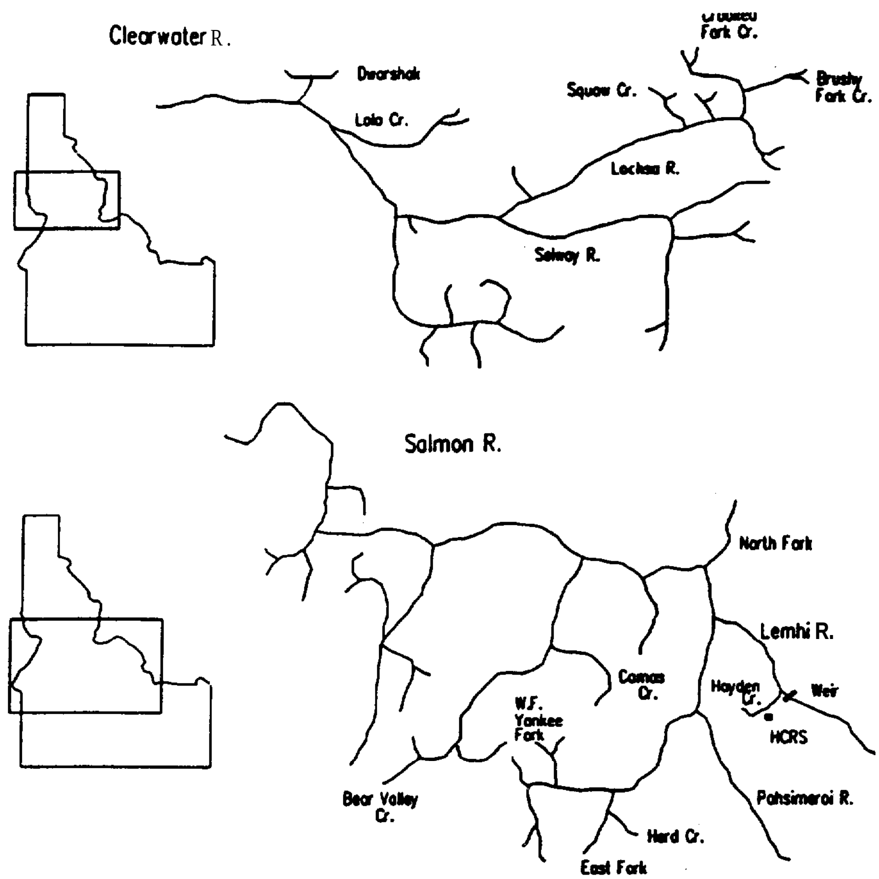

Figure 1. Study area used during the 1992 field season.

Study area

The controlled experiments, during which we observed the interactions between hatchery and natural chinook salmon, were conducted at the Hayden Creek Research Station (HCRS) in the Lemhi River Valley about 53 km (33 miles) southeast from the town of Salmon, Idaho (Figure 1). HCRS is three miles up Hayden Creek from the Lemhi River. The downstream movement of chinook salmon juveniles, and the upstream movement of chinook salmon adults were monitored at the Lemhi River weir located just upstream from the mouth of Hayden Creek. Chinook salmon were also PIT tagged at the weir to determine survival rates from the Lemhi River to Lower Granite Dam (about 443 river km).

Summer population estimates of chinook salmon were made for the Lemhi River upstream from the Lemhi River weir using electroshocking techniques. The results of this sampling will be discussed in the Idaho Department of Fish and Game portion of this report.

The dispersion of 10,000 hatchery chinook salmon was monitored in Squaw Creek during the summer and of early fall of 1992. Squaw Creek is a tributary of the upper Lochsa River, about 11.3 km (7 miles) downstream from Powell, Idaho (Figure 1).

Chinook salmon were collected from 12 streams in the Salmon and Clearwater River drainages to establish a genetic database of these naturally produced populations. The streams sampled in the Salmon River drainage were Bear Valley Creek, West Fork of the Yankee Fork, East Fork, Herd Creek, Pahsimeroi River, Lemhi River, Camas Creek, and the North Fork of the Salmon River. The streams sampled from the Clearwater drainage were Brushy Fork Creek, Crooked Fork Creek, Red River, and Lo10 Creek. In addition two hatcheries were sampled, the East Fork Satellite Station (these fish were housed at Sawtooth Fish Hatchery) and Dworshak National Fish Hatchery.

Objective 1. Dispersion rates of **stocked chinook salmon in Squaw Creek**

On 23 July 1992 10,000 chinook salmon parr from Rapid River Hatchery were released into Squaw Creek, 4.8 km (3 miles) upstream from the confluence with the Lochsa River. Prior to their release we snorkeled the creek to confirm that there were no resident chinook salmon present. Snorkelers were in the water to observe the fish behavior during the release. Following the release, and again the next day, six transects were snorkeled to determine the densities of the hatchery chinook salmon as well as the resident trout populations up and downstream from the release site (Table 6). We returned and snorkeled Squaw Creek three more times through the summer to monitor the dispersion of the hatchery chinook salmon from the release site. During the later surveys seven more transects were added to the original six, for a total of 13 transects, to allow closer monitoring of the downstream dispersion of the hatchery chinook salmon from the release site.

Results

No naturally produced chinook salmon were found in Squaw Creek prior to the release of the hatchery chinook salmon. The fish were released from a truck at the side of the stream. During the release the fish were initially swept downstream a distance of 5 to 10 m before orientating themselves facing upstream. Many of the first fish released began to form dense schools near the bottom and along the margin of the stream in the slow water velocity areas, while the last fish to be released were forced into the swifter water and were swept further downstream. At this time it appeared that several resident trout were being

Table 1. Densities of hatchery chinook salmon (fish/m2) observed during snorkel surveys of Squaw Creek following release date. Location represents the distance upstream (+) or downstream from stocking site (site 3).

Site	Location	Release 23 July	24 July	1 Aug.	12 Aug.	10 Sept.
1	+0.8 km	0	0	0	0	0
2	+ 30 m	0	0.4	0.6	0.6	0.5
3	0	71.0	13.2	3.8	1.9	0.6
4	0.2 km			0.7	0.3	0.08
5	0.6 km			0.3	0.4	0.3
6	1.1 km			0.03	0.04	0.04
7	1.6 km	0	0	0	0	0.04
8	2.1 km			0	0	0.01
9	2.6 km			0	0	0.01
10	3.2 km	0	0	0	0	0.03
11	3.7 km			0	0	0.02
12	4.2 km			0	0	0
13	4.8 km	0	0	0	0.01	0.03

physically pushed downstream by the mass of moving hatchery fish. It was also observed that the hatchery fish began unselective feeding almost immediately after hitting the water. It appeared that the fish were ingesting any object small enough to fit into their mouths as it was encountered.

During snorkel surveys made immediately after the release, and on the following day, we found the hatchery fish were concentrated in dense schools in the first 0.3 km of stream downstream from the release site. Almost no fish were seen upstream from the release site. Nine days (1 August) and 20 days (12 August) following the release the hatchery chinook salmon were still found in highest densities at the release site and occupied the length of stream from 1.1 km downstream from the release site to 30 m upstream from the release site. The hatchery fish were unable to move any further upstream than this because of a log weir which prohibited accession. At 49 days (10 September) following release, we found hatchery chinook salmon at all but one site in the 4.8 km section of stream between the release site and the confluence with the Lochsa River. Just prior to this survey a cold front had passed through the area. The resulting cold water temperatures (4-6 C) may have prompted the hatchery chinook salmon fingerlings to disperse downstream.

Our observations agree with those of Richards and Cernera (1989) who found that fingerling chinook salmon planted into the Yankee Fork of the Salmon River were found in highest abundance within two km downstream of the release site. The low rate of dispersion of hatchery chinook salmon following release into infertile Idaho streams may indicate the need to use multiple release sites to reduce the chance of overloading single stream sections.

Objectives 2 &3. Hayden Creek Research Station Flume Studies size-density experiemnts.

As stated previously, the factors important to the success of a supplementation project is the survivability of the hatchery fish and any possible negative impacts they will have on the existing fish populations in the receiving waters. The major focus of the small-scale studies in 1992 was to investigate the importance of fish size and density on the potential interactions that occur between hatchery and naturally-produced chinook salmon, and how these interactions influence predation pressure on the juvenile chinook salmon in a natural setting. To accomplish this, a series of experiments were designed to be run in the flume located at the Hayden Creek Research Station. The flume (44 m long, 1.8 m wide, and 1.2 m deep) was divided into 12 equal sections, each built to mimic a natural riffle-pool-riffle complex. Cobble, gravel, brush bundles, and overhead cover were added to each section to imitate a natural stream setting.

The experimental trials consisted of placing various numbers of hatchery and/or natural chinook salmon into the artificial stream sections for two week periods, during which observations were made of fish numbers and behavior through view ports set into the sides of the flume. In the spring, the hatchery fish were added to the artificial stream sections first and the wild fish were added later to simulate the situation where hatchery fish were stocked as fry prior to natural fish emergence. During later trials, the hatchery fish were "stocked" into the stream sections already holding natural fish. Observations were made four times a day to examine habitat use, feeding, and aggressive behaviors of the hatchery and natural fish. Traps built into the upstream and downstream ends of each section were emptied daily to monitor voluntary movement patterns. The experiments were repeated through the year to study the hatchery/natural interactions as both groups of fish increased in size. The five treatments used during the trials were as follows, (1) hatchery fish alone, (2) natural fish alone, (3) equal numbers of hatchery and natural fish, (4) twice the number of hatchery fish as natural fish, or (5) twice the number of natural fish as hatchery fish. The first two treatments were the control treatments, and the last three are referred to as the test treatments. During the first four trials, the number of fish placed in each section totaled 30. For the last two trials 60 fish were used in each section. Treatments were duplicated during each experimental trial (n = 2).

The hatchery fish used for the trials were marked with a small clip to the upper caudal lobe to differentiate them from the natural fish during observations. Hatchery fish used for the flume studies were provided from Rapid River Hatchery while the natural fish were collected from the Lemhi River using the downstream migrant trap. Following a trial, the hatchery fish were moved to holding tanks and the natural fish were PIT-tagged and returned to the Lemhi River. We used only naive fish for the experiments to eliminate learned behavior bias in later trials.

The predation experiments (objective 3) were intended to resemble the trials described above, except that an adult brook trout would be added to several of the sections to determine which group of chinook salmon (hatchery or natural) were preferentially preyed on. But, due to the low numbers of wild fish collected early in the year the predation experiments were not conducted and the number of hatchery/natural interaction trials scheduled to be run was reduced.

Statistical analysis

Movement behavior. - Analysis of variance was used to identify significant differences in the proportion of the chinook salmon remaining in each artificial stream section between fish type (hatchery or natural) and treatments. Tukey's Standardized Range test was used to compare differences between means. All tests were significant at the 0.05 alpha level.

Active vs. concealed fish. - The active chinook salmon were those fish which were not concealed, that is, they were the fish counted during an observation period. The measure of active fish within an artificial stream section was the number of fish counted during an observation period, divided by the number of fish removed from that section at the end of the trial. This value represents the maximum proportion of fish which could be active during an observation period. Differences in the proportion of active fish between the hatchery and natural chinook salmon and treatments were determined using analysis of variance and Tukey's Standardized Range test at the 0.05 alpha level.

Habitat use. - This analysis was used to determine if the hatchery and natural chinook salmon utilize the same habitat types when together as when they were separate. The habitat used by the chinook salmon within each artificial stream section was recorded during the daily observations by assigning individual fish to ***one*** of seven cells according to habitat type. The seven habitat types included (1) open riffles, (2) riffles with overhead cover, (3) riffles with in-stream cover, (4) open water column, (5) water column with overhead cover, (6) pool bottom with cobble substrate, and (7) pool bottom with silt substrate. Fish observed exhibiting cover-seeking behavior (e.g. within the interstitial of the pool bottom cobble) were not assigned to one

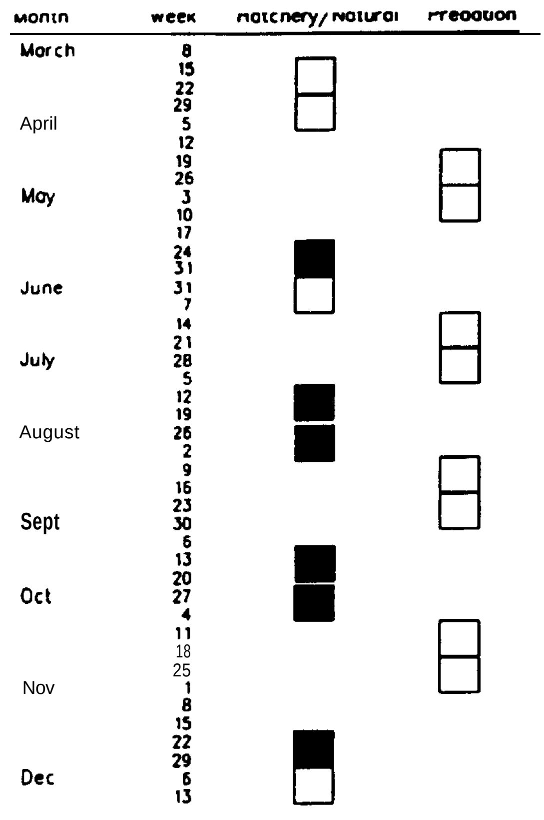

Figure 2. Experimental trials scheduled to be run at Hayden Creek Research Station in 1992. Solid boxes represent trial completed during 1992.

of the habitat units since these were considered to be inactive fish.

The number of each fish type found in one habitat type was divided by the total number of fish of that type observed during each observation period to obtain the proportional use of each habitat class. These values were **arcsine** transformed to normalize the data. We used separate repeated measure analysis of variance on the transformed proportions to identify differences for each fish type using habitat class and treatment as the independent variables. When no difference was noted with respect to the repeated variable (within-subject effects) the data was averaged across the repeated variable and the analysis was re-run for the between-subject effects. In all cases there was no difference in the outcomes of the two analysis. Comparisons of means were made using **Tukey's** Standardized Range **test.** All tests were evaluated for significance at the alpha = **0.05** level.

Table 2. Dates, water temperatures, and the initial lengths and weights of the hatchery and natural chinook salmon used in the six experimental trials.

Trial	Date	Water Temp. C	Initial length & weight Hatchery	Natural
Spring	18-29 May	12.5	52.7 mm	***39.7 mm***
Summer I	22 June-3 July	12.5	63.7 mm 3.0 g	98.1 mm 10.7 g
Summer II	6 July-17 July	13.5	67.8 mm 3.6 g	101.6 mm 11.8 g
Fall I	14-26 Sept	13.2	89.1 mm 9.2 g	115.3 mm 18.5 g
Fall II	28 Sept-10 Oct	14.5	92.8 mm 10.1 g	113.3 mm 17.9 g
Winter	4-14 Nov	2.9	98.7 mm 12.0 g	110.5 mm 15.8 g

Aggression. - Aggression exhibited by the chinook salmon during experimental trials were recorded for each treatment during periodic ten minute observation periods. The aggressive encounters included obvious displays, charges, chases, and nips, and were classified according to the aggressor/aggressee pair as hatchery-hatchery, hatchery-natural, natural-hatchery, or natural-natural. The aggression rates in each of the four classes was the number of encounters per aggressor fish per minute for each observation period. Differences in aggression rates between the four classes, fish type, and treatments were tested using analysis of variance and **Tukey's** Standardized Range test at the 0.05 alpha level.

Results

Eighteen experimental trials were scheduled to be run in 1992. But due to the low numbers of natural chinook salmon collected in the downstream migrant trap, only six trials could be completed, one in the spring, two each during the summer (summer I **&** II trials) and fall (fall I **&** II), and one trial during the winter (Figure 2, Table 2). We were also unable to include all five treatments during each of the trials. During the summer II trial, treatment four (twice the number of natural as hatchery fish) was not included, and during the summer I and fall I trials

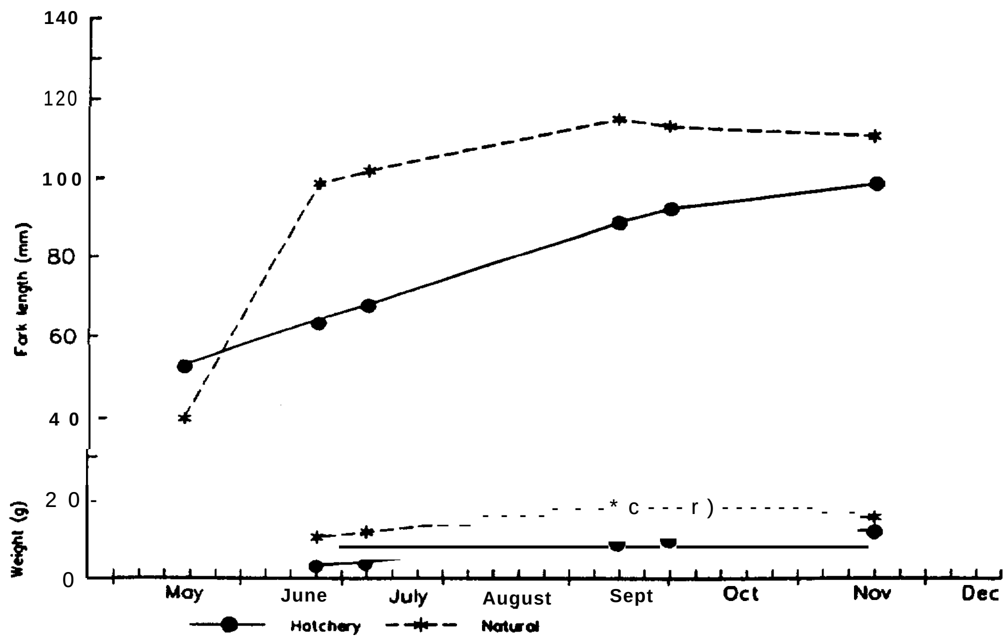

Figure 3. Lengths and weights of hatchery and natural chinook salmon used for the six experimental trials run in 1992.

treatments four and five (twice the number of hatchery as natural fish) were eliminated.

Movement behavior.

Movement from the artificial stream sections generally varied between the experimental trials ($P < 0.05$) (Table 3) but there was few significant differences found between the hatchery and natural chinook salmon, or between the treatments. For most of the trials there was a trend for more hatchery fish than natural fish to leave the artificial stream sections. For the treatments, there was again a trend for more hatchery fish to move from the sections, except when there were more hatchery than natural fish present.

In the first summer trial, more than twice the number of hatchery than natural chinook salmon left the artificial stream sections, although the difference was not significant ($P = 0.09$). During the summer II trial fewer natural fish remained in the artificial stream sections when there was an excess of hatchery fish present than when equal numbers or no hatchery fish were present. ***No*** other significant differences were found for movement-patterns data from the six trials.

Table 3. Numbers and percentages of hatchery (H) and naturally produced (N) chinook salmon remaining in flume sections at the end of trials. Area of each artificial stream section = 6 m^2.

Treatment	1	2	3		4		5		Mean	
	H	N	H	N	H	N	H	N		
Init. no.	30	30	15	15	10	20	20	10	H	N
Spring I	15 50%	28 93%	10.5 70%	7 47%	5 50%	6 30%	8.5 43%	7.5 75%	53%	61%
Summer I	5 17%	16.5 55%	4.5 30%	10 67%					24%	61%
Summer II	15.5 52%	29 97%	12 80%	12 80%			10 50%	5.5 55%	61%	77%
Fall I	24.5 82%	28.5 95%	13 87%	13 87%					85%	91%
Init. no.	60	60	30	30	20	40	40	20		
Fall II	48 80%	51 85%	30 100%	26.5 88%	19.5 98%	35.5 89%	35.5 89%	17 85%	92%	79%
Winter I	26.5 44%	34.5 58%	20.5 68%	24 80%	15 75%	39 98%	22.5 56%	15.5 78%	61%	79%
Mean	54%	81%	73%	75%	60%	73%	74%	62%		

Active vs concealed fish

Of the total number of fish in each artificial stream section only a portion were active during an observation period. The remaining fish were exhibiting cover-seeking behavior in the substrate on the pool bottom and among the branches of the in-stream brush.

In general, the hatchery fish were more active than the natural fish but there was little detectable difference between treatments. In the spring more hatchery fish were observed swimming about the artificial stream sections than the natural chinook salmon. The natural chinook salmon were less active when alone (control treatment) or when they outnumbered the hatchery fish (treatment 5, see table 4), but less active when with equal or excess numbers of hatchery fish (treatments 3 and 4). The natural chinook salmon seeking refuge could be seen occasionally moving in and out of the interstices of rocks on the pool bottom.

Table 4. Average proportion of hatchery (H) and naturally produced (N) chinook salmon active (observed) in artificial stream sections during observation periods

Treatment	1	2	3		4		5		Mean	
	H	N	H	***N***	H	N	H	N		
Init. no.	30	30	15	15	10	20	20	10	H	N
Spring I	93%	64%	97%	85%	99%	57%	95%	80%	96%	72%
Summer I	85%	75%	82%	79%					84%	77%
Summer 11	73%	87%	82%	92%			***93%***	91%	83%	90%
Fall I	86%	58%	***93%***	48%					90%	53%
Init. no.	60	60	30	30	20	40	40	20		
Fall II	83%	76%	87%	74%	87%	70%	83%	69%	85%	72%
Winter I	79%	70%	96%	31%	82%	40%	100%	28%	89%	42%
Mean	83	72	***90%***	68%	89%	56%	93%	67%		

During the Summer I trial, there was a trend for less active natural fish than hatchery fish, but the differences were not significant. There were also no differences found in the proportion of active fish during the summer II trial. In the fall the hatchery chinook salmon were again more active than the natural fish within all treatments, with no difference among treatments.

During the winter, the natural chinook salmon were more active in the control treatments than the test treatments while the hatchery fish were less active when alone than when in combination with natural fish, but the differences were not significant. The hatchery fish were more active than the natural chinook in all treatments.

Habitat use.

There was little difference in the habitat used by the active hatchery and natural chinook salmon observed during the trials, with some exceptions. Habitat use by the hatchery chinook salmon varied little between the treatments. However, for the natural chinook salmon, there were differences observed between treatments in four of the six trials (Table 5).

In the spring, the natural chinook salmon made greater use of the riffles than the pools while the hatchery chinook were spread between the open riffles and the surface water of the pool. During the summer I trial, the hatchery and natural chinook salmon used similar habitats. Both groups used the pool bottom and the surface water associated with the overhead cover. Less use was made of the riffles during this trial than in the spring.

There was a significant difference in the use of habitat by natural fish between the four treatments during the second summer trial. When the natural fish were alone, significantly more were found near the surface and the overhead cover and on the bottom among the substrate. When there were equal numbers of hatchery and natural chinook together, the natural fish were evenly dispersed through the bottom and surface waters of the pool. When there were excess hatchery fish present, the natural fish shifted to the pool bottom among the substrate and to under the overhead cover. The hatchery fish had a similar pattern of habitat use as the natural fish, with more fish on the bottom and under the overhead cover and fewer fish using the open water and the riffles.

During the first fall trial, the natural chinook salmon made greater use of the pool bottom when alone and were found on the pool substrate and under the overhead cover when in combination with the hatchery chinook salmon. The hatchery chinook salmon were mainly in the pool water column and on the pool bottom during this trial. In the second fall trial, almost all of the natural chinook salmon were found on the bottom of the pool among the rock substrate. With increased numbers of hatchery fish we saw a significant shift in habitat use to the pool surface waters, a pattern resembling the habitat use patterns of the hatchery chinook salmon.

For the winter trial, the natural chinook salmon were spread between the bottom substrate and the open water column. The hatchery fish were found mainly in the open surface water. During this trial there was increased use of the riffles associated with the instream cover by both hatchery and natural chinook salmon.

Aggression

Aggression between and among the hatchery and natural chinook salmon was observed during four of the six trials. In general, the hatchery chinook salmon were more aggressive than the natural chinook salmon, especially to other hatchery fish than to the natural fish (Figure 4).

During the spring trial, when the hatchery fish were larger than the natural chinook salmon (Figure 3), the aggression rate varied between treatments ($P < 0.05$), but there was no difference between the aggressive classes ($P = 0.09$). The aggression between hatchery fish was significantly higher than the other three aggressive classes, which were not significantly different from each other. Aggression by hatchery chinook salmon on

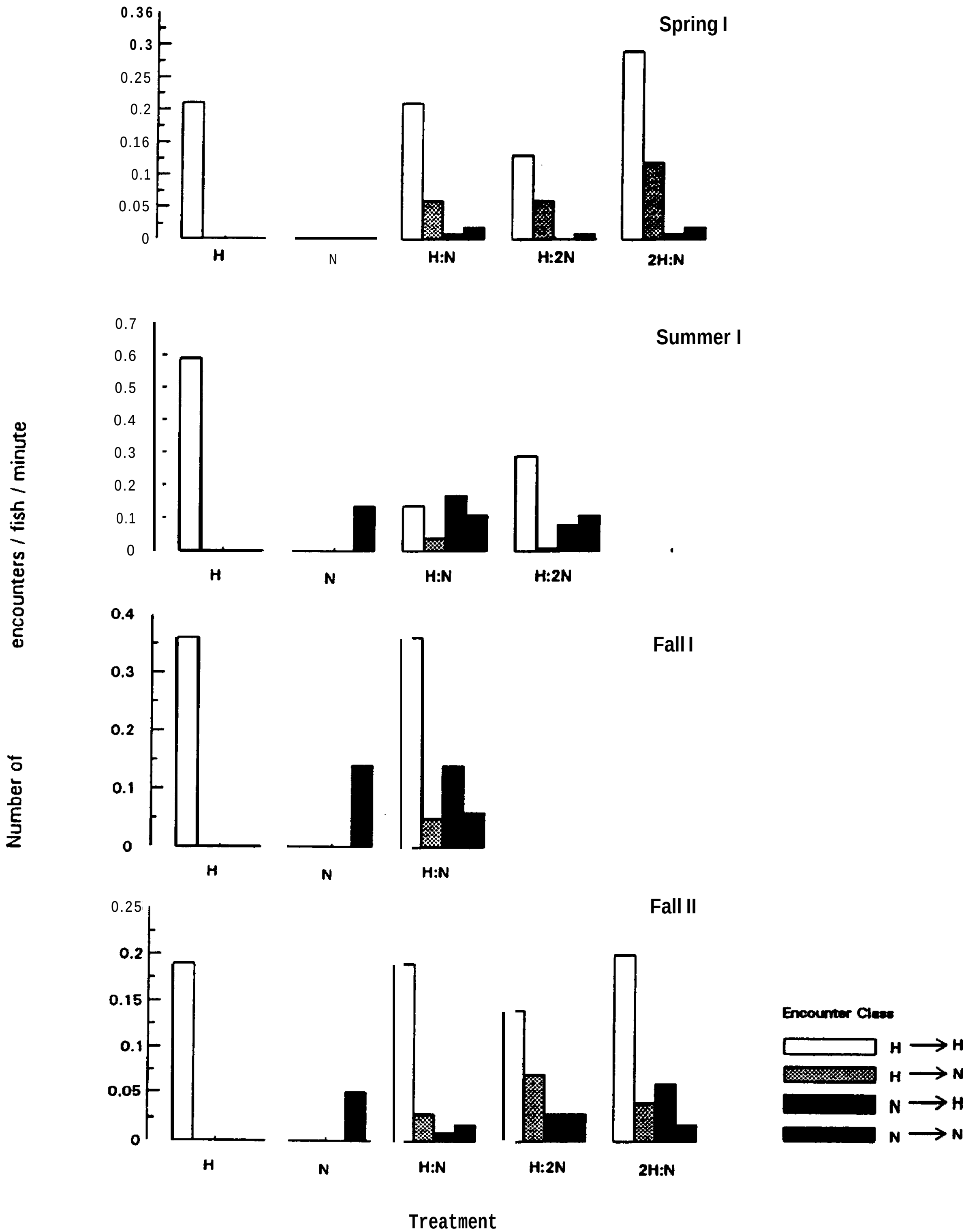

Figure 4. Aggression recorded during the spring, summer II and fall I and II experimental trials. Treatments indicate the ratio between hatchery (H) and natural (N) chinook salmon in tests.

natural fish was highest in the test treatments when they outnumbered the natural fish. Aggression between natural fish was the lowest of the four classes and no aggressive encounters were observed in the natural fish control treatments.

During the summer II trial the aggressive rate between hatchery fish were again significantly higher than the other three classes (P = 0.03). Aggressive rates were highest in the control treatments when the hatchery chinook salmon were separate from the natural fish. For this trial, in which the natural chinook salmon had surpassed the size of the hatchery fish for the first time, aggression by hatchery fish on natural fish was minimal and aggression by the natural fish increased. Similar patterns of aggression were observed during the fall I and II trials: aggression rates between hatchery fish were significantly higher than the other three classes, although it was not as exaggerated in the control treatments. Aggression between the hatchery and natural chinook salmon was little affected by the treatments.

Discussion

The purpose of the flume studies was to identify the interactions which occur when hatchery and natural chinook salmon are combined into a natural setting. Our strategy was to compare the behavior of the fish when alone in the control treatments with that when the hatchery and natural fish were combined. The experimental trials were repeated through the year to observe progression of hatchery-natural chinook salmon interactions with fish size. The positive and negative aspects of these interactions could then be incorporated into future chinook salmon supplementation projects to improve the productivity of both the hatchery and natural fish.

We experienced several problems during this start-up year of the project. First, fewer than the desired number of experimental trials were completed during 1992 due the low number of natural chinook salmon collected from the Lemhi River. We were forced to reduce the total number of fish used in each artificial stream section from 60 to 30 fish per section, except in the fall II and winter trials when natural fish were abundant. We also limited the number of treatments used during some trials according to the number of fish available.

In much of our analysis we were unable to detect statistically significant differences between the behaviors recorded in the different treatments. This was probably due to the low number of replicates (n = 2) which were run during each experimental trial. We had hoped to combine closely run trials (such as summer I & II and fall I & II trials) to increase our replication, but significant differences precluded pooling across trials. In 1993, we plan to run fewer treatments but higher replication of the treatments per trial so that we can better detect differences between treatments when they are present.

Another difficulty was the sizes of the fish used in the trials. Typically hatchery fish are larger than the natural fish in the waters to be supplemented. The natural chinook salmon used for this stdy were collected from the Lemhi River, which is known to be a productive stream (Bjornn 1978). Initially, in the spring, the natural chinook salmon we collected were smaller than the hatchery fish, but by the summer trials the natural fish had surpassed the size of the hatchery chinook salmon (Figure 3). This makes application of the results from this year's experiments to other less fertile Idaho streams difficult. In 1993 , we will attempt to rectify this problem by using differential rearing regimes to obtain a wider range of the hatchery fish sizes. We also recommend collecting natural chinook salmon from alternate streams in the Idaho Batholith.

Movement behavior

There was a tendancy for more hatchery than natural chinook salmon to leave the artificial stream sections. Most fish left the stream sections at night using the upstream traps. We noted that the hatchery fish were more mobile than the natural fish. Natural fish would typically remain in one area of the artificial stream sections, whereas hatchery fish were more likely to roam from the pool bottom up to the water column and back, or to move from the upstream riffle to the downstream riffle during an observation period. Increased roaming within the stream sections may have facilitated the emigration of the hatchery chinook salmon from the sections. Roaming-like behavior has been observed for hatchery brown trout in a Pennsylvania River (Bachman 1984). During that study the hatchery brown trout altered their position in the stream constantly and their numbers declined rapidly from the time they were added. In contrast, the resident trout tended to maintain the same homeranges over several years (Bachman 1984). Chinook salmon planted as fingerlings in the Yankee Fork of the Salmon River were also observed to move downstream out of the system earlier than the naturally produced chinook salmon subyearlings (Richards and Cernera 1989). In that case it was thought that the early downstream movement was related to the larger size of the hatchery fish. However, during all but the first of our trials, the hatchery fish were smaller than the natural chinook salmon, and most of the fish left the flume sections via the upstream traps.

Active vs concealed fish

Of the fish that remained in the artificial stream sections a higher proportion of the hatchery chinook salmon were visible during the observation periods. Conversely, a higher proportion of the natural chinook salmon exhibited cover-seeking behavior during the trials. The use of cover for refuge by naturally-produced salmonids has been documented (Bjornn and Reiser 1991; Edmunson et al. 1968; Everest and Chapman 1972; Hillman et al. 1989), as well as the lack there of in hatchery salmonids (Hillman and Mullan 1989; Vincent 1960). This type of behavior is beneficial to the stream-dwelling chinook salmon. The lack of this type of behavior in hatchery fish may make them more susceptible to predation and less energy efficient. Natural rearing strategies incorporated into the hatchery environment may help reduce this behavior tendancy.

Habitat use

The use of habitat by the hatchery and natural chinook salmon within the artificial stream sections were similar within trials but varied between trials. In the spring both types of fish made greater use of the riffles than of the pools. Natural fish were found near the instream cover and the hatchery fish were more in the open. In the summer both types of fish were found more in the pool areas and less on the riffles. This agrees with the findings of Everest and Chapman (1972) who observed that post-emergent chinook salmon in two Idaho streams were found mainly in the shallow low velocity waters and shifted to the deeper, swifter waters as they increased in size. Similar observations were made for juvenile chinook salmon in the Wenatchee River (Hillman et al. 1989).

During the fall both types of fish were again found mainly in the pools and rarely on the riffles. We noted a behavioral shift in habitat use by the natural chinook salmon in the fall when combined with increasing numbers of hatchery fish. This was most obvious in the fall II trial. When the natural chinook salmon were alone in the control treatment the majority of the fish were found on the pool bottom near the cobble substrate. But when the natural fish were combined with low numbers of hatchery fish, more natural fish were found in the pool water column with a few on the pool bottom. As more hatchery fish were added to the flume sections, in treatments 3 and 5, the distribution of the natural fish came to resemble that of the hatchery fish. This shift in behavior of natural fish when in the presence of hatchery fish agrees with the observations of Hillman and Mullan (1989) who observed the behavior of chinook salmon during the release of hatchery chinook salmon into the Wenatchee River. Hillman and Mullan (1989) reported that as the hatchery fish moved downstream the natural chinook salmon would leave their usual stations at the shallow river margins and join the hatchery fish at the center of the river near the surface. Thus, in the presence of the greater numbers of hatchery fish, the natural chinook salmon would mimic the behavior of the hatchery fish. It was further noted that in leaving the refuge of the marginal waters, the natural chinook salmon became targets of selective feeding by resident trout in the system.

In the winter trial the hatchery chinook salmon were found mainly in the pool water column while the natural fish were

Table 5. Averaged percentage habitat use by hatchery and natural chinook salmon by trial. Habitat comparisons denotes similar use of habitat units.

	Riffles			Pool bottom		Pool top		
Habitat Unit	open 1	instream cover 2	overhead cover 3	open bottom 4	substrate bottom 5	overhead cover 6	open water 7	Habitat Unit Comparisons
Spring								
Natural	11.2	15.5	6.9	0.9	2.4	7.4	6.7	2 1 6 3 7 5 4
Hatrchery	14.7	3.9	3.0	3.8	5.9	13.9	7.9	1 6 7 5 2 4 3
Summer I								
Natural								
Treat 2	7.4	8.5	14.3	38.5	48.8	42.4	21.8	5 6 4 7 3 2 1
Treat 3	12.8	6.5	12.4	34.7	39.5	43.1	29.7	6 5 4 7 3 1 2
Hatchery	4.5	1.7	5.3	8.9	18.3	18.7	7.5	5 6 4 7 3 1 2
Summer II								
Natural								
Treat 2	12.6	11.0	15.8	29.3	44.7	45.1	31.3	6 5 7 4 3 1 2
Treat 3	16.0	10.9	12.7	29.9	42.2	37.9	33.1	5 6 7 4 1 2 3
Treat 5	7.3	8.2	11.3	34.3	54.3	28.9	18.3	5 4 6 7 3 2 1
Hatchery	5.3	3.4	7.9	11.3	13.4	14.4	9.7	5 6 4 7 1 3 2
Fall I								
Natural								
Treat 2	0.02	2.8	0.6	14.3	36.7	0.6	2.7	5 4 2 7 3 6 1
Treat 3	0.5	3.6	5.3	7.5	25.7	17.4	4.9	5 6 4 3 7 2 1
Hatchery	0.6	2.4	2.6	7.8	13.3	19.6	18.0	6 7 5 4 3 2 1
Fall II								
Natural								
Treat 2	0.0	0.6	0.07	4.2	45.9	0.0	0.2	5 4 2 3 6 7 1
Treat 3	0.0	1.7	1.6	3.2	12.1	6.7	31.1	7 5 6 4 2 3 1
Treat 4	0.0	0.6	0.08	1.4	5.4	1.5	41.9	2 5 4 6 2 3 1
Treat 5	0.5	2.8	4.0	2.7	8.9	9.3	29.4	7 6 5 3 2 4 1
Hatchery	0.7	1.4	1.6	2.9	8.5	18.8	27.3	7 6 5 4 3 2 1
Winter								
Natural	0.3	5.7	0.2	1.5	20.1	6.1	18.2	5 7 2 6 4 3 1
Hatchery	0.2	10.9	0.2	0.04	5.9	1.1	32.5	7 2 5 6 3 1 4

Treatments

1 Hatchery
2 Natural
3 Hat-Nat
4 1/3H 2/3 N
5 2/3H 1/3N

divided between the pool bottom and the pool water column. Both types of fish made greater use of the riffles at this time than had been observed since the spring trial. This was due to the cover-seeking behavior juvenile chinook salmon exhibit at low water temperatures (Edmunson et al. 1962; Everest and Chapman 1972).

In some instances it has been observed that the introduction of hatchery fish can displace the natural salmon from their preferred habitat (Bachman 1984; Nickelson et al. 1986; Hillman and Mullan 1989; Spaulding et al. 1989). This may have been the case during our experimental trials since the distribution of the natural chinook salmon varied between the test and control treatments in four of the six treatments and, on average, fewer natural fish remained in the artificial stream sections during the test than the control treatments. However, more replicates of these testes are needed before conclusions can be drawn.

The implications of habitat displacement of natural fish by hatchery fish can be serious. Natural chinook salmon displaced from their natal rearing areas may be forced to use less favorable habitat which may reduce their growth and survival (Chandler and Bjornn 1988). The natural fish would be replaced by hatchery salmonids, which may be behaviorally and genetically inferior to their naturally produced counterparts (Bachman 1984; Mesa 1991; Nickelson et al. 1986; Sosiak et al. 1979; Swan and Riddell 1990; Vincent 1960). Additionally, hatchery salmonids that survive to return and spawn naturally, such as hatchery steelhead released into the Deschutes River, Oregon (Reisenbicher and McIntyre 1977) and the Kalama River, Washington (Campton et al. 1991; Chilcote et al. 1986; Leider et al. 1990) may have lower reproductive success than the naturally spawning resident salmonids. Thus it is possible that a supplementation program may inadvertently replace the target population with a population having a lower survival and reproductive potential. This risk may be lessened in streams with very low natural seeding levels, and thus containing underutilized habitat. We plan to closer investigate the occurrence of habitat displacement of natural chinook salmon by hatchery fish in this coming year's studies.

Aggression

Hatchery chinook salmon were more aggressive than natural chinook salmon in the four trials where aggression was quantified. In addition, the hatchery fish were more aggressive between themselves than towards the natural fish, even in those treatments where the hatchery fish were in lower numbers. The overt aggressiveness of hatchery-produced salmonids has been. observed by several researchers (Bachman 1984; Mason and Chapman 1965; Mesa 1991; Swan and Riddell 1990). The aggressiveness of the hatchery fish appeared to have little direct effect on the natural chinook salmon during the trials, but it may have important implications in the survival of the hatchery fish.. A fish which spends more time and energy in aggressive behavior will have less energy for food gathering. And, while the aggressive fish may procure a superior feeding position, the gains in food energy may not necessarily compensate for the energy expended. In short, overt aggressiveness may not be cost effective in terms of the food budget and can reduce the survival of an individual fish (Bachman 1984; Mesa 1991; Swan and Riddell 1990). Aggressiveness may also make a small fish more vulnerable to predation. We believe that this is primarily a learned trait developed during the hatchery residence, and so may be reduced through alternative hatchery practices, such as the use of lower rearing densities.

Objectives 4 & 6. Chinook salmon emigration study and PIT tag detections at Lower Granite Dam.

Chinook salmon juveniles collected at the Lemhi weir were tagged using passive integrated transponders (PIT tags) to estimate the minimum survival of downstream migrants from the Lemhi River to Lower Granite Dam. In the mornings, the fish to be tagged were moved to the tagging shed adjacent to the Lemhi weir and anesthetized using tricaine methansulphanate (MS-222). The PIT tag was injected into abdomen of the fish using a 12 gauge hypodermic needle, lengths and weights were recorded, and the fish were placed in a live box just upstream from the weir to recover. The tagged fish were generally released in the evening at the town of Lemhi, 1.6 km upstream from the weir, so that recaptures could be made the following morning. Three release sites were used in the spring of 1992; the town of Leadore about 94 km upstream from the Lemhi-Salmon River confluence, the Lemhi weir, and the town of Salmon at the mouth of the Lemhi River, to address objective four. The three release sites were used to determine the differential travel time and mortality associated with fish that must travel the length of the Lemhi River (from the Leadore release site) compared to those released at the weir and at the mouth of the river.

We had hoped to PIT-tag 500 juvenile chinook salmon in the fall of 1991, 900 fish in the spring of 1992 (300 per release site), 500 in the summer and another 500 in the fall of 1992. In the fall of 1991 a total of 584 chinook salmon were PIT-tagged and released at Lemhi. However, only 206 chinook salmon were tagged in the spring and 113 in the summer of 1992 due to the low number of fish moving early in the year. A total of 604 chinook salmon were tagged in the fall of 1992.

Results

of the 584 juvenile chinook salmon tagged and released in the fall of 1991, 100 (17.1%) were detected at Lower granite Dam in the spring of 1992. The average travel time between the Lemhi weir and Lower Granite Dam was 155.6 days (s = 11.95).

Of the 206 chinook salmon PIT-tagged in the spring of 1992, 74 were released at the mouth of the Lemhi River, 80 were released at the Lemhi weir, and 52 were released at the headwaters of the Lemhi River. Detections of these fish at Lower Granite Dam totalled 23 (11.2%). Detections from each release site totalled 14 (18.9%) from the mouth of the Lemhi River, 15 (18.8%) from the Lemhi weir and four (7.7%) from the Lemhi River headwaters, with average travel times of 24.6, 28.1 and 25.4 days, respectively. The level of detection of the tagged chinook salmon from the three release sites were not significantly different from expected assuming equal probability of detection (Chi-square, $P > 0.1$).

Discussion

Our goal for objective 4 was to use PIT-tagged chinook salmon to determine if fish that travel the length of the Lemhi River had lower survival and longer travel times to Lower Granite Dam than fish travelling from the Lemhi weir and mouth of the river. This information will be used to determine the appropriate release site to be used when the Lemhi River becomes a supplementation treatment stream. There was no significant difference in the travel times of the fish from the three release sites that were detected at Lower Granite Dam. There may be lower survival for fish released at the headwaters of the Lemhi River than for fish released at the two downstream sites, although the difference was not significant for the one replicate tested to date. The lack of significance is probably due to the low sample size of tagged and detected chinook salmon from each site.

The young-of-the-year chinook salmon tagged in the fall of 1991 had significantly greater travel times to Lower Granite Dam than yearling fish tagged in the spring of 1992. These chinook salmon pre-smolts were emigrating from natal rearing areas to downstream over-wintering areas, where they would hold until the spring-time outmigration to the ocean. This pre-smoltification emigration may be a mechanism adapted by a portion of the population which prevents exceding the winter carrying capacity of the natal rearing areas. It is possible that a portion of the population will persist to exhibit a propensity to emigrate early to an intermediate rearing are, even though the current low level of the Lemhi River chinook salmon population makes it unlikely that winter habitat is limiting.

Objective 5. Chinook salmon downstream movement in the Lemhi River 1991-1992

Downstream movement of chinook salmon juveniles in the Lemhi River was monitored using the downstream migrant trap located at the Lemhi River weir. The Lemhi River weir consists of removable metal racks angling 60° to the downstream flow (Figure 5). The downstream migrant trap, which was restarted the fall of 1991, is located along the west bank of the river at the downstream-most end of the weir (see Bjornn 1978). Under normal operating conditions the trap samples approximately 10% of the Lemhi River. During low water conditions, plastic sheeting material is placed over the weir racks to divert more water through the trap. Fish entering the trap at the weir are guided by de-watering louvers to a perforated metal live box, where they are held until the trap is emptied. During sampling, the live box is raised and the fish become concentrated into a depression set into the solid bottom, from which the fish can be dip netted out.

The downstream migrant trap at the Lemhi River weir was operated from 5 October until 30 November, 1991. In 1992 it was operated continuously from 30 January until 20 November. The trap was checked twice a day, in the morning between 0800 and 0900, and in the evening between 1700 and 1800. During each sampling, we recorded the number and lengths of the chinook salmon and trout collected, the number of other fish species in the trap, the air and water temperatures and water depth.

Statistical analysis.

Periodically through the year PIT-tagged chinook salmon were released 1.6 km upstream from the weir to determine the sampling efficiency of the trap. Population estimates were made using the equation developed by Chapman (1951) as discussed by Ricker (1975),

$$N = \frac{(M + 1)(C + 1)}{(R + 1)} \qquad [1]$$

and

$$V(N) = \frac{M2(C - R)}{(C + 1)(R + 1)}, \qquad [2]$$

where M is the number of fish marked at time t, C is the number of fish caught at time t + 1, R is the number of marked fish recaptured at t + 1 and N is the estimated number of fish moving past the weir at t + 1. Ricker (1975) suggests that R should be at least three to reduce bias. Days in which recaptures totaled less than three were grouped so that R was three or more. The number of fish moving for each group of days was then estimated

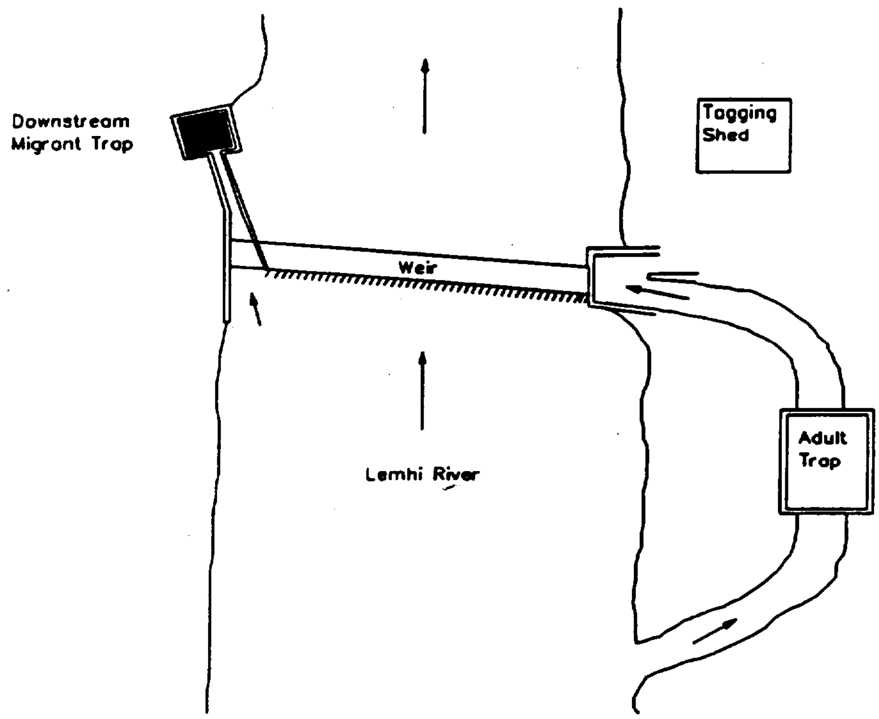

Figure 5. Lemhi River weir with upstream and downstream migrant traps.

and summed for each season the trap was operated in 1991 and 1992.

Results

During the two months (54 days) of operation in the fall of 1991, a total of 660 young-of-the-year (YOY) (brood year 1990) chinook salmon were collected at the Lemhi River weir (Table 6). During this period, the capture efficiency of the trap averaged 18.7% and the total movement of YOY chinook salmon past the Lemhi weir was estimated to be 7,554 fish.

In 1992 the downstream migrant trap was operated from 30 January until 20 November. During this period, a total of 1,935 YOY (brood year 1991) and 256 yearlings (brood year 1990) chinook salmon were collected (Table 6). There were three distinct migration groups coinciding loosely with the spring, summer, and fall seasons (Figure 6).

In the spring of 1992 (30 January - 31 March) a total of 128 YOY and 210 yearling chinook salmon were collected. This was the highest movement of yearling chinook salmon during 1992. The capture efficiency of the trap for the spring averaged 18.5% and the number of YOY and yearling chinook salmon moving past the

Table 6. Chinook salmon collected, and estimated movement (and standard deviation) at the Lemhi River weir in 1991 and 1992.

Season	Collected YOY	Collected YRL	Recapture Efficiency	Est. Movement YOY (SD)	Est. Movement YRL (SD)
Fall 91	660	0	18.7%	7,554 (25)	0 (0)
Spring 92	128	210	18.5%	1,080 (18)	1,472 (23)
Summer 92	426	3		3,400 (na)	32 (na)
Fall 92	1,381	43	10.9%	13,799 (50)	418 (7)
Total 1992	1,935	256	14.9%	18,279 (48)	1,921 (14)
Overall '1991-92	2,595	256	?	25,833	1,921

Lemhi weir was estimated to be 1,080 and 1,472, respectively (Figure 7).

The number of chinook salmon collected during the summer of 1992 (1 June - 31 August) totalled 426 YOY and 3 yearlings. A large portion of these YOY were collected during the last part of

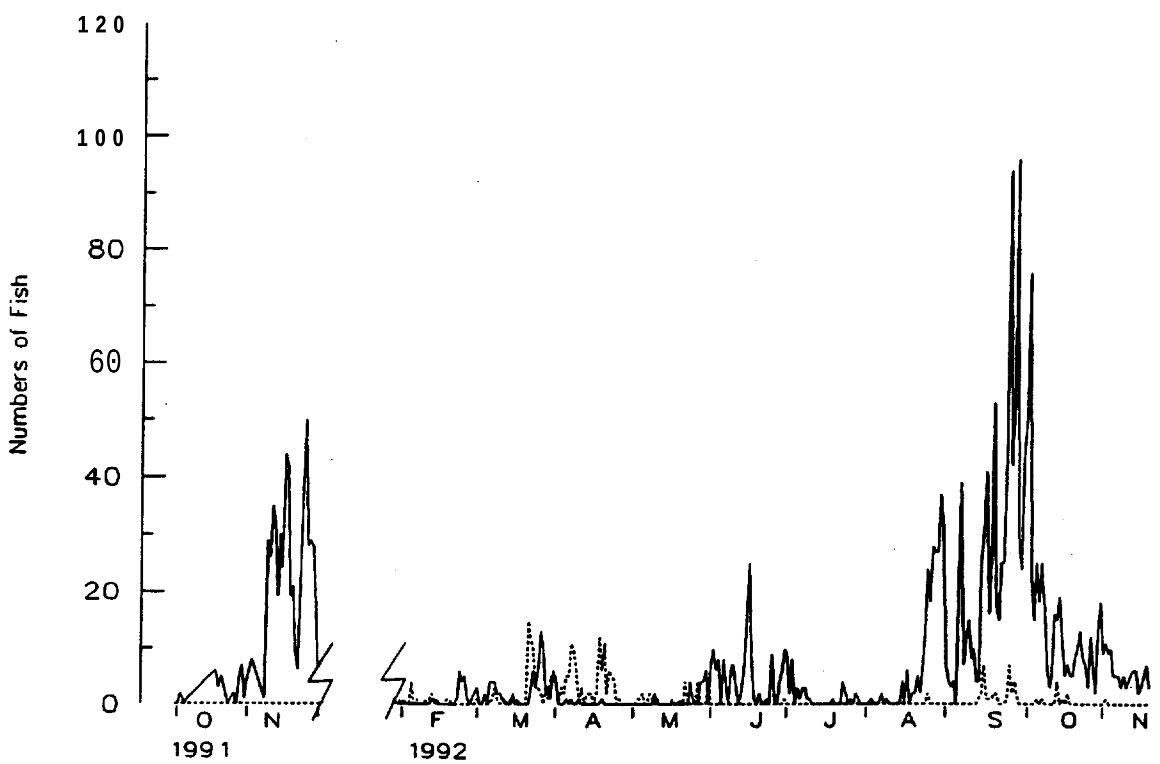

Figure 6. Chinook salmon trapped at the Lemhi weir in 1992. The solid line represents YOY, the dashed line represents yearlings.

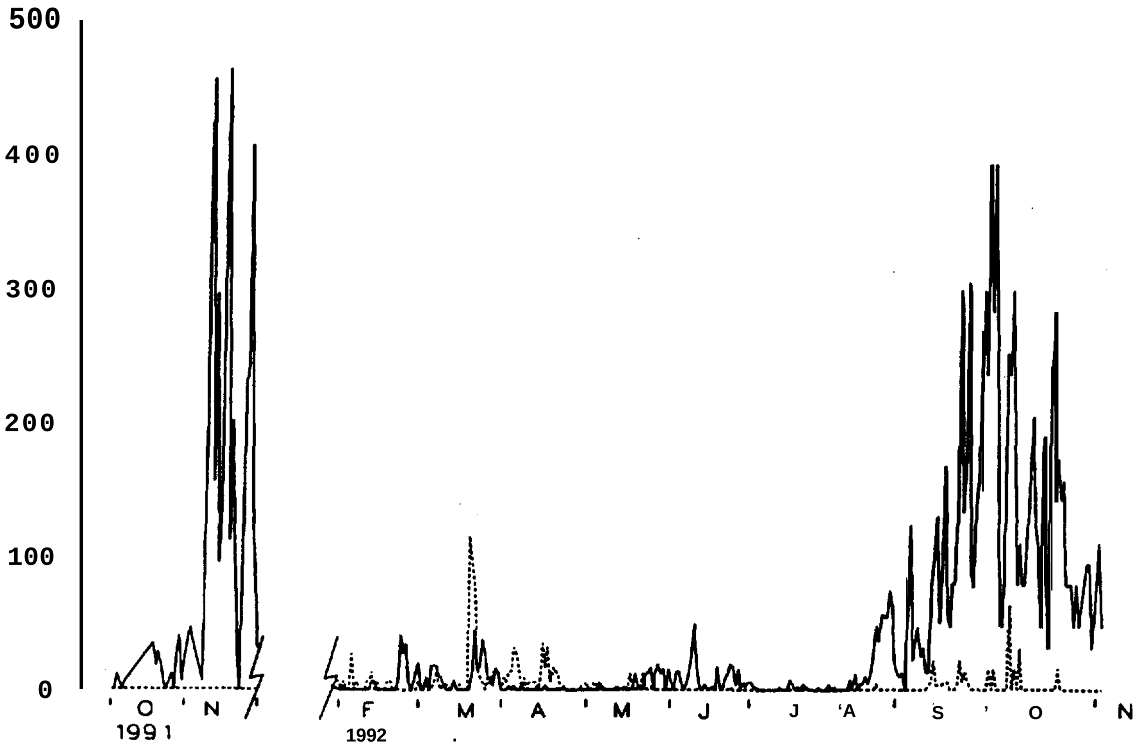

Figure 7. Estimated movement of chinook salmon juveniles past the Lemhi River weir in 1991 and 1992. Solid line represents YOY and the dashed line represents yearlings.

August (Figure 6). Due to the low number of tagged fish released upstream from the weir during the summer, the capture efficiencies of the trap could not be calculated, but were estimated using the catch rates recorded during other periods of similar flow and weir conditions. The number of chinook salmon moving past the weir during the summer of 1992 was thus estimated to be 3,400 YOY and 32 yearlings.

The peak number of chinook salmon collected at the Lemhi weir occurred during the fall of 1992 (1 September - 20 November). **During** this period a total of 1,381 YOY and 43 yearling chinook salmon were collected. Most of the yearlings were precocious males collected during the latter parts of the spawning season in late September. The capture efficiency of the trap for the fall **averaged 10.9% and the estimated movement** was **13,799 YOY and 418** yearlings.

The capture efficiency of the trap for entire 1991-92 field seasons averaged 14.9% and the total number of chinook salmon **estimated to have moved downstream** while the trap was operating **totalled** 25,833; **9,476 from** brood-year 1990 and 18,279 from brood-year 1991.

Discussion

The number of chinook salmon reported to be moving downstream in 1991-92 are significantly lower than that reported from 20-30 years previous (Bjornn 1978). During the period from 1963 until 1974 Bjornn (1978) reported that the estimated total chinook salmon moving past the Lemhi River weir ranged from 0.3 to 1.2 million fish. The pattern of movement we saw in 1991-92 also differed from that reported by Bjornn (1978), with the majority of chinook salmon moving downstream as presmolts in the fall of 1992 rather than newly emergent fry as in 1963-74. The recapture rates we observed in 1991-92 ranged from 10.9 to 18.5%, higher than the 1.7 to 5.2% reported by Bjornn (1978). The discrepency is probably due to more efficient trap design in 1991-92. We altered the structure of the Lemhi weir and used plastic sheeting material over the weir racks to divert more water and fish into the trap.

Objective 6. Adult salmon movement in the Lemhi River - 1992

The upstream migrant trap at the Lemhi River weir was repaired and put into operation on 5 August 1992. Returning adult salmon and steelhead reaching the Lemhi weir are diverted by the metal racks to the adult trap via a side channel situated on the east bank of the river (Figure 5). The fish pass over a finger weir to enter the trap where they remain until the false floor is raised and they are allowed to swim out the exit chute at the head of the trap. As the fish leave, they are counted and classified as one-, two-, or three-ocean fish according to length markings on the exit chute. The fish then continue to swim upstream for approximately 100 m to where the channel re-joins the river.

The adult trap at the Lemhi weir was operating by 5 August 1992. After 5 August a total of 33 adlt chinook salmon passed through the trap. There were two one-ocean fish, 14 two-ocean fish, and 16 three-ocean fish. We did not attempt to sex the fish as they passed through the trap to eliminate handling stress. Redd counts for the Lemhi River were conducted by the Salmon Office of IDFG by helicopter. Only six redds were sighted from the air in the section of river upstream from the Lemhi weir during the fall of 1992.

Objective 7. Chinook salmon collections for genetic analysis.

During 1992, 586 naturally-produced chinook salmon pre-smolts and 200 hatchery-produced smolts were collected from 12 streams

Table 7. The locations and number of chinook salmon collected for genetic analysis in 1992.

Location	No.	Mean Length	(SD)	Date Collected
Salmon River drainage				
Bear Valley Creek	75	79.9	5.1	26-27 Aug. 1992
West Fork Yankee Fork	55	76.0	6.5	27-28 Aug. 1992
East Fork Salmon River	54	77.2	7.8	28-29 Aug. 1992
Herd Creek	53	83.1	6.2	29 Aug. 1992
Pahsimerio River	39	91.8	7.0	30-31 Aug. 1992
Lemhi River	74	110.6	7.0	8-11 Nov. 1992
Camas Creek	55	72.5	6.3	2 Sept. 1992
North Fork Salmon River	56	79.4	7.1	3 Sept. 1992
East Fork Satellite	100	120.6	8.5	19 Feb. 1993
Clearwater River drainage				
Brushy Fork Creek	19	72.3	5.9	4 Sept. 1992
Crooked Fork Creek	50	75.4	5.6	4 Sept. 1992
Red River	11	81.0	4.2	7 Sept. 1992
Lolo Creek	45	96.7	29.8	15 Sept. 1992
Dworshak Hatchery	100	126.0	14.5	18 Feb. 1993

and two hatcheries to establish a genetic database of these populations (Table 7). The database will be used to monitor possible shifts in the genetic makeup of target populations following supplementation as identified in the ISS study plan (Bowles and Leitzinger 1991). Most fish were collected using a backpack electroshoker at selected sites in each stream or river. The collection sites were spaced at least 0.8 km apart and no more than 11 fish were collected from a site to reduce the chance that the fish were progeny from the same redd. Baited minnow traps were used to collected the chinook salmon from Lolo Creek, with the assistance of the Nez Perce Tribe biologists. The sample from the Lemhi River came from the downstream migrant trap. After the chinook salmon were collected they were anesthetized in MS-222 and then frozen in liquid nitrogen. The electrophoretic analysis of the collected samples will be conducted by the Washington Department of Fisheries at their' Olympia, Washington, laboratory.

We attempted to collect between 50 and 75 chinook salmon from each stream and 100 from the hatcheries. This was possible in all but Brushy Fork Creek and Red River-due to the low number of fish present in these two streams. A total of 67 chinook salmon were collected from **Lolo** Creek. Unfortunately, one sample of 22 fish was accidently thawed out and could not be used for the analysis.

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GENETIC ANALYSIS OF 1991 IDAHO CHINOOK SALMON BASELINE COLLECTIONS

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JULY, 1992

INTRODUCTION

This report describes the results of our analysis of the genetic characteristics of chinook baseline collections made in 1991 from selected rivers in Idaho. Chinook juveniles were sampled by Idaho Fish and Game and sent to us for analysis. WDF staff responsible for various laboratory tasks of this project were: Bruce Baker, Bill Ingram, Lisa Rhodes, Rita Sneva, Norm Switzler, and Beth Vorderstrasse. Dr. Craig Busack provided assistance with computer programs for data analysis, and he and Dr. Jim Shaklee assisted with data interpretation.

METHODS

Laboratory

Four tissues, muscle, eye, heart, and liver, were dissected from the whole chinook juveniles sent to our lab. The tissue samples were placed in labeled test tubes and stored at -80°C prior to electrophoresis. "Test" samples from the Sawtooth hatchery were used to develop the best electrophoretic protocol for these juveniles based on the amount, types, and biochemical activity of the tissues available. The protocol using muscle, eye, and liver tissues, which was used for all fish, and the protocol for heart, which was only used on the large hatchery juveniles, are both provided in Appendix I. These procedures allowed us to resolve 54 to 56 loci. We screened several other enzyme systems initially (bGLUA, G3PDH, GDA, LGL) but dropped them due to poor activity. The loci and alleles screened, with their relative mobilities and data codes, are listed in Appendix II.

Phenotype data from the gels were entered directly into computer files via WDF's interactive scoring program. All gels were independently double-scored at all loci. Many loci were screened in two or more tissues and on two different buffers in order to ensure accuracy of the data. Samples were rerun to resolve any scoring discrepancies found in the initial analysis.

The sixteen baseline collections made by IFG were given unique codes in our lab. These codes are on the test tube labels as well as in the computer data files for each collection. The names of the collections, their codes, and sample size are listed in Table 1.

Table 1. Chinook salmon (spring-run) juvenile collections made in 1991 by Idaho Fish & Game, with WDF collection codes and sample sizes.

Collection Code	Location sampled	Sample Size
91NA	Lemhi R.	50
91NB	Pahsimeroi R.	50
91NC	Crooked Fork Crk.	50
91ND	Brushy Fork Crk.	13
91NE	Red R.	50
91NF	South Fk. Salmon R.	51
91NG	Bear Valley Crk.	50
91NH	Upper Valley Crk.	23
91NI	W. Fk. Yankee Fork	50
91NJ	East Fk. Salmon R.	20
91NK	Herd Crk.	50
91NL	Camas Crk.	50
91NM	North Fk. Salmon R.	30
91NN	Lo10 Crk.	36
91NO	Dworshak Hatchery	102
91NP	East Fk. Salmon R. Hatchery	90

Data Analvsis

The genotype data gathered by electrophoresis was analyzed using the BIOSYS-1 program (Swofford and Selander 1981) to provide allele frequencies, chi-square tests for conformance to Hardy-Weinberg genotypic proportions, average heterozygosities, and genetic distance statistics for each collection. For the collections with a sample size of 50 or larger, the unweighted pair-group method (Sneath and Sokal 1973) was used with genetic distance values to produce dendrograms illustrating relationships among these collections. G-tests (log-likelihood ratio tests) of the heterogeneity of allele frequencies were performed for each pair of collections with N $\geq$ 50, using polymorphic loci only. Two variable isoloci (sAAT-1,2 & sMDH-B1,2), and one variable locus that is scored reliably only in a homozygous state (sMEP-2) had to be excluded from several of these analyses, and these cases are described in the Results section.

RESULTS

Samples

The non-hatchery juveniles were too small for heart tissue to be of use. The amount of liver tissue available from some very small fish was also limiting. The heart tissue from the large hatchery juveniles from the East Fork Salmon R. Hatchery showed better activity than the Dworshak Hatchery samples.

A sample labeling problem in the field allowed us to analyze only 20 fish out of 40 from the East Fork Salmon R. collection and only 30 fish out of 50 from the North Fork Salmon R. collection. Upon receiving the samples from Idaho, several collections were missing. Although more of the samples were subsequently sent over, we still did not have any fish from the North Fork Salmon R. and we seemed to have more East Fork Salmon R. samples than indicated in field notes. Phone conversations with the samplers did not help us resolve this problem. During dissection of the fish labeled East Fork Salmon R. we figured out that the North Fork Salmon R. collection had been labeled "East Fork" and thus became mixed in with true East Forks. Further conversations with samplers enabled us to identify the right fish from both collections (by sampling date), and a reduced sample size was the result. This situation may be salvageable because the mixed carcasses and dissected tissues are available, but this needs to be discussed due to the extra work involved and the potential risks.

The sample size of five collections, Brushy Fork Creek, Upper Valley Creek, East Fork Salmon R., North Fork Salmon R., and Lo10 Creek, was less than 50, which is considered a minimum sample size for genetic characterization. These five collections were not used in most genetic variability calculations because they are not an adequate represention of the population sampled.

Genetic Variation

Allele frequencies for all sixteen collections at 54 loci are presented in Table 2. Data for four isolocus pairs (sAAT-1,2, sMDH-A1,2, sMDH-B1,2, sIDHP-1,2) are mean frequencies computed over both loci of the pair. Data for the individual loci sIDHP-1 and sIDHP-2 are also given in Table 2, due to our current ability to distinguish variation expressed at each locus (Shaklee and Phelps 1992). Frequencies for sIDHP-1,2 will be useful for comparison with data from older electrophoretic studies in which data were collected without the knowledge of how to score the loci-independently. The frequencies for GPIr and sMEP-2 are genotype frequencies. Only homozygous phenotypes for the common or variant alleles at these two loci are scored because heterozygotes are not reliably distinguished.

Uncommom or rare variation was seen at several loci. For example, the sAAT-1,2*105 allele, the sAAT-3*113 allele, the sIDHP-2*66 allele, the LDH-C*84 allele, the sMDH-B1,2*126 allele and the mSOD*142 allele. Relatively high frequencies of the mMDH-2*200 allele, the sMEP-1*92 allele, and the sIDHP-1*74 allele were seen in many of the collections. The frequencies for IDDH-2 reported in Table 2 should be considered preliminary at this time. Due to variation present at IDDH-1, it was sometimes difficult to distinguish variation at IDDH-2.

Some potential genetic variation was observed but was not included in Table 2. The GAPDH-2 and GAPDH-3 loci were not clearly expressed in the heart tissue from the hatchery juveniles. The GAPDH locus or loci in muscle samples showed patterns of expression that were difficult to interpret when compared to heart samples from the same fish. However, about half of all the collections showed possible variation at the GAPDH locus expressed in muscle (presumably GAPDH-3). Unfortunately, this variation could not be verified in heart because the fish were too small. The allele frequencies for GAPDH-3 in Table 2 represent only fish that appeared to be monomorphic. Further laboratory work may help resolve these problems, especially if larger juveniles are available in the future.

The only tissue that expressed the mAH-2 locus reliably was heart from the larger hatchery juveniles. The Dworshak Hatchery sample had a few fish that possibly had the mAH-2*83 allele, and the East Fork Salmon River Hatchery had a frequency of approximately 9% for the mAH-2*83 allele.

Genetic Variabilitv Analysis

Only the collections having a sample size of 50 or larger were used to test for Hardy-Weinberg proportions. The variable isoloci sAAT-1,2 and sMDH-B1,2 and the locus sMEP-2 (only homozygotes scored) were not included in these tests. For the 11 collections, 181 tests were made and 10 showed significant ($p<0.05$) departures from expected genotypic frequencies. Overall, this is a low rate of significance since 5% would be expected to be significant by chance alone. The highest rate of significant tests for a collection was 14% for Red River, whereas several collections had no significant tests.

Over all collections, variation was found at 31 of the 54 loci screened (excluding sAH-2 and GAPDH-31. Several measures of genetic variablitiy were calculated over 46 loci for the 11 large ($N \geq 50$) collections and are presented in Table 3. Loci and isoloci not included in these calculations were GPIr, sMEP-2, sAAT-1,2, sMDH-A1,2, and sMDH-B1,2. The percentage of loci polymorphic at the .99 level (common allele frequency < .99 in at least one collection) ranged from 30.4% to 43.5% per collection. These levels of variation are similar to ones reported for other Snake River chinook salmon populations (Waples et al. 1991) and for chinook of the Yakima River basin (Busack et al. 1991). Average heterozygosity values (average percent of heterozygous loci per fish) for the 11 collections are also shown in Table 3. They ranged from .040 to .068. These values conform closely with those expected from Hardy-Weinberg proportions.

Table 2. Allele frequencies at 54 loci in 16 1991 Idaho chinook baseline collections. N = number of fish scored at each locus.

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
sAAT-1,2									
(N)	50	50	50	13	49	51	50	23	49
100	0.995	1.000	1.000	1.000	1.000	0.995	0.995	0.968	0.984
85	0.005	0.000	0.000	0.000	0.000	0.005	0.005	0.033	0.000
105	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.015
sAAT-3									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	0.900	0.978	1.000
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
113	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.022	0.000
sAAT-4									
(N)	41	45	40	11	37	38	45	20	43
100	0.939	0.967	0.912	1.000	0.959	0.934	0.867	1.000	0.988
130	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65	0.061	0.033	0.087	0.000	0.041	0.066	0.133	0.000	0.012
mAAT-1									
(N)	47	50	39	12	42	48	50	23	48
-100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
-77	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-104	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mAAT-2									
(N)	44	46	37	12	42	41	50	23	43
-100	0.875	0.902	0.797	1.000	0.940	0.988	0.990	0.978	0.826
-125	0.011	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-90	0.114	0.098	0.203	0.000	0.060	0.012	0.010	0.022	0.174
ADA-1									
(N)	50	50	50	13	49	51	50	23	50
100	0.960	0.920	0.980	1.000	0.959	0.922	0.970	0.957	0.970
83	0.040	0.080	0.020	0.000	0.041	0.078	0.030	0.043	0.030
ADA-2									
(N)	50	50	50	13	50	51	50	22	47
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ADH									
(N)	46	49	40	11	47	50	50	23	47
-100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(continued)

Table 2. (cont.)

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
sAH									
(N)	50	49	49	13	50	50	50	23	50
86	1.000	0.990	0.990	1.000	1.000	1.000	1.000	1.000	1.000
112	0.000 0.000	0.000 0.000	0.000 0.010	0.000	0.000	0.000	0.000	0.000	0.000
				0.000	0.000	0.000	0.000	0.000	0.000
108	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mAH-3									
(N)	50	50	50	13	50	51	50	23	50
100	1 .000	1.000	1 .000	1 .000	1.000	1.000	1.000	1 .000	1.000
mAH-4									
(N)	50	50	50	13	50	50	50	23	50
100	1.000	1.000	0.940	1.000	1.000	0.990	1.000	1.000	1 .000
119	0.000	0.000	0.060	0.000	0.000	0.010	0.000	0.000	0.000
CK-Al									
(N)	50	50	50	13	50	50	49	23	50
100	1.000	1.000	1 .000	1 .000	1.000	1.000	1 .000	1.000	1 .000
CK-A2									
(N)	50	50	50	13	49	50	49	23	50
100	1.000	1 .000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GAPDH-3									
(N)	48	50	27	11	40	46	47	18	49
100	1.000	1.000	1.000	1 .000	1.000	1.000	1 .000	1.000	1 .000
GAPDH-4									
(N)	50	50	50	13	50	51	50	23	50
100 .	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GPI-B1									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1 .000	1.000	1.000	1.000	1.000	1 .000	1.000	1 .000
GPI-B2									
(N)	50		50	13	50	51	48	23	50
100	1.000	1.000 50	1.000	1.000	1.000	0.922	0.937	1 .000	1 .000
60	0.000	0.000	0.000	0.000	0.000	0.078	0.062	0.000	0.000
GPI-A									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(continued)

Table 2. (cont.)

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
GPIr									
(N)	1.000 50	1.000 50	1.000 50	1.000 13	50	51	50	23	50
100					1.000	1.000	1.000	1.000	1.000
GR									
(N)	50	49	50	13	50	49	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HAGH									
(N)	50	50	50	13	50	51	50	23	50
100'	0.950	0.920	0.930	0.923	0.980	0.922	0.990	0.957	0.880
143	0.050	0.080	0.070	0.077	0.020	0.078	0.010	0.043	0.120
IDDH-1									
(N)	47	48	41	13	44	42	39	22	49
100	0.872	0.979	0.976	1.000	0.977	0.988	0.949	0.977	0.990
0	0.128	0.021	0.024	0.000	0.023	0.012	0.051	0.023	0.010
IDDH-2									
(N)	50	48	41	13	43	45	41	23	49
100	0.950	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
61	0.050	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mIDHP-1									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
mIDHP-2									
(N)	1.000 50	1.000 50	1.000 49	1.000 13	50	51	50	23	50
100					1.000	1.000	1.000	1.000	1.000
sIDHP-1,2									
(N)	50	50	50	13	49	47	50	23	50
100	0.925	0.900	0.870	0.942	0.944	0.889	0.810	0.815	0.905
127	0.015	0.000	0.030	0.000	0.000	0.006	0.010	0.065	0.015
74	0.030	0.070	0.095	0.019	0.026	0.058	0.180	0.109	0.050
142	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94	0.030	0.030	0.005	0.038	0.030	0.048	0.000	0.011	0.025
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
129	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.005

(continued)

Table 2. (cont.)

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
sIDHP-1									
(N)	50	50	50	13	49	47	50	23	50
100	0.880	0.800	0.800	0.885	0.888	0.787	0.640	0.761	0.850
74		0.140	0.190	0.038	0.051	0.117	0.360	0.217	0.100
142	0.060 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94		0.060	0.010	0.077	0.061	0.096	0.000	0.022	0.050
129	0.060 0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
sIDHP-2									
(N)	50	50	50	13	50	51	50	23	50
100	0.970	1 .ooo	0.940	1.000	1.000	0.990	0.980	0.870	0.960
127	0.030	0.000	0.060	0.000	0.000	0.010	0.020	0.130	0.030
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.010
LDH-Bl									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
LDH-B2									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1 .ooo	0.990	1.000	1.000	1.000	0.940	1 .ooo	0.990
112	0.000	0.000	0.010	0.000	0.000	0.000	0.060	0.000	0.010
LDH-C									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	0.990	1.000	1.000	1.000	1.000	1.000	1 .ooo
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
84	0.000	0.000	0.010	0.000	0.000	0.000	0.000	0.000	0.000
sMDH-A1,2									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1 .ooo	1.000	1.000
sMDH-B1,2									
(N)	50	50	50	13	50	51	50	23	50
100	0.990	0.985	0.990	1.000	1.000	0.990	0.965	0.968	0.995
121	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
126	0.010	0.015	0.010	0.000	0.000	0.010	0.035	0.033	0.005

(continued)

Table 2. (cont.)

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
mMDH-2									
(N)	46	49	49	13	49	51	50	23	50
100	0.707	0.765	0.765	0.962	0.837	0.735	0.580	0.587	0.800
200	0.293	0.235	0.235	0.038	0.163	0.265	0.420	0.413	0.200
mMDH-3									
(N)	48	50	50	13	49	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
sMEP-1									
(N)	48	49	49	13	50	51	50	22	48
100	0.031	0.071	0.010	0.000	0.060	0.020	0.060	0.091	0.021
92	0.969	0.929	0.990	1.000	0.940	0.980	0.940	0.909	0.979
sMEP-2									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	0.980	1.000	1.000	1.000
78	0.000	0.000	0.000	0.000	0.000	0.020	0.000	0.000	0.000
MPI									
(N)	50	50	50	13	49	51	50	23	50
100	0.980	0.910	0.870	0.962	0.918	0.912	0.990	0.891	0.890
109	0.020	0.090	0.130	0.038	0.082	0.088	0.010	0.109	0.110
PGDH									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGM-1									
(N)	49	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGM-2									
(N)	49	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGK-2									
(N)	50	50	50	13	50	51	50	23	50
100	0.110	0.110	0.240	0.038	0.140	0.137	0.110	0.217	0.050
90	0.890	0.890	0.760	0.962	0.860	0.863	0.890	0.783	0.950
PEPA									
(N)	50	50	50	13	50	51	50	23	50
100	0.980	1.000	0.980	1.000	1.000	1.000	1.000	0.978	1.000
90	0.020	0.000	0.020	0.000	0.000	0.000	0.000	0.022	0.000

(continued)

Table 2. (cont.)

COLLECTIONS 1 THROUGH 9

LOCUS/ALLELE	LEMHI	PAHSIMEROI	CROOKED	BRUSHY FK	RED	SF SALMON	BEAR VAL	UPPER VAL	WF YANKEE
PEPB-1									
(N)	50	50	50	13	49	51	50	23	50
100	0.780	0.880	0.910	0.923	0.806	0.971	0.950	0.935	0.620
130	0.140	0.090	0.040	0.000	0.153	0.020	0.050	0.043	0.170
-350	0.080	0.030	0.050	0.077	0.041	0.010	0.000	0.022	0.210
PEPD-2									
(N)	50	50	5 0	13	50	51	50	23	50
100	1.000	1.000	1.000	1 .ooo	1.000	0.931	1.000	1.000	1.000
107	0.000	0.000	0.000	0.000	0.000	0.069	0.000	0.000	0.000
PEP-LT									
(N)	50	50	50	13	50	51	50	23	50
100	0.970	0.870	0.950	1 .ooo	0.920	0.892	0.830	0.826	0.930
110	0.030	0.130	0.050	0.000	0.080	0.108	0.170	0.174	0.070
sSOD-1									
(N)	50	50	50	13	50	51	50	23	50
-100	0.960	0.950	0.950	1 .ooo	0.970	0.961	0.970	0.978	0.910
-260	0.040	0.050	0.050	0.000	0.030	0.039	0.030	0.022	0.090
mSOD									
(N)	50		50	13	50	51	50	23	49
100	1.000	1.000 50	1.000	1.000	1.000	0.971	0.920	1.000	1.000
142	0.000	0.000	0.000	0.000	0.000	0.029	0.080	0.000	0.000
TPI-1									
(N)	50	50	50	13	50	51	50	23	50
100	1 .ooo	1.000	1.000	1.000	1.000	1.000	1 .ooo	1.000	1.000
TPI-2									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1 .ooo	1.000	1.000	1.000
TPI-3									
(N)	50	50	50	13	50	51	50	23	50
100	1.000	1.000	1.000	1.000	1.000	1.000	1 .ooo	1.000	1.000
TPI-4									
(N)	50	50	50	13	50	51	50	23	50
100	0.970	0.920	0.980	0.923	0.970	0.892	0.920	0.848	0.900
104	0.030	0.080	0.020	0.077	0.030	0.108	0.070	0.152	0.100
96	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
102	0.000 0.000	0.000 0.000	0.000 0.000	0.000	0.000	0.000	0.000	0.000	0.000
				0.000	0.000	0.000	0.010	0.000	0.000

(continued)

Table 2. Allele frequencies at 54 loci in 16 1991 Idaho chinook baseline collections - cont.

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
sAAT-1,2							
(N)	20	50	50	30		102	90
100	1.000	0.975	0.955	0.983	1.20	1.000	0.989
85	0.000	0.025	0.045	0.016	0.000	0.000	0.006
105	0.000	0.000	0.000	0.000	0.000	0.000	0.006
s(N)-3							
100	0.975 20	1.000 50	1.000 50	1.000 30	1.000 36	1 102 .000	1.000 90
90	0.000	0.000	0.000	0.000	0.000	0.000	0.000
113	0.025	0.000	0.000	0.000	0.000	0.000	0.000
sAAT-4							
(N)	19	44	32	25	27	97	65
100	0.947	1.000	0 797	0.980	0.833	0.933	0.962
130	0.000	0.000	0: 000	0.000	0.000	0.005	0.000
63	0.053	0.000	0.203	0.020	0.167	0.062	0.038
! (N)-1		49					
-100	1.000 20	1.000	0.979 48	1.000 30	1.000 35	1 102 .000	1.000 90
-77	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-104	0.000	0.000	0.021	0.000	0.000	0.000	0.000
mAAT-2							
(N)	20	47	39	30	24	99	69
-100	1.000	1.000	0.962	0.983	0.958	0.899	1.000
-125	0.000	0.000	0.000	0.000	0.000	0.000	0.000
-90	0.000	0.000	0.038	0.017	0.042	0.101	0.000
ADA-							
(N)	20	50	50	30	36	102	90
100	0.850	0.980	0.870	1.000	0.986	0.961	0.883
83	0.150	0.020	0.130	0.000	0.014	0.039	0.117
ADA-2							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
ADH							
(N)	19	50	50	29	35	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(continued)

Table 2. (cont.)

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
sAH							
(N)	20	50	50	30	36	102	90
100	0.950	1.000	1.000	1.000	1.000	1.000	1.000
80	0.050	0.000	0.000	0.000	0.000	0.000	0.000
116	0.000	0.000	0.000	0.000	0.000	0.000	0.000
108	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mAH-3							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
mAH-4							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	0.980	1.000
119	0.000	0.000	0.000	0.000	0.000	0.020	0.000
CK-A1							
(N)	20	49	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
CK-A2							
(N)	20	49	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GAPDH-2							
(N)	20	48	50	30	35	101	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GAPDH-4							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GPI-B1							
(N)	20	50	50	29	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GPI-B2							
(N)	20	50	50	29	35	100	90
100	1.000	1.000	1.000	1.000	0.971	1.000	0.978
60	0.000	0.000	0.000	0.000	0.029	0.000	0.022
GPI-A							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000

(continued)

Table 2. (cont.)

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
GPIr							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GR							
(N)	20	50	50	30			90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
HAGH							
(N)	20	50	50	30	36	102	90
100	0.925	0.980	0.920	0.917	0.917	0.951	0.900
143	0.075	0.020	0.080	0.083	0.083	0.049	0.100
IDDH-1							
(N)	20	46	39	28	29	95	82
100	0.875	0.935	0.974	1.000	0.897	0.953	0.963
0	0.125	0.065	0.026	0.000	0.103	0.047	0.037
IDDH-2							
(N)	20	46	41	28	29	95	81
100	1 .ooo	1.000	1 .ooo	1.000	1.000	1.000	1.000
61	0.000	0.000	0.000	0.000	0.000	0.000	0.000
mIDHP-1							
(N)	20	50	50	29	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1 .ooo
mIDHP-2							
(N)	20	50	50	29	36	101	90
100	1 .ooo	1 .ooo	1.000	1.000	1.000	1.000	1.000
sIDHP-1,2							
(N)	20	50	49	29	35	102	90
100	0.887	0.850	0.959	0.939	0.893	0.941	0.914
127	0.025	0.075	0.000	0.000	0.000	0.000	0.000
74	0.050	0.050	0.026	0.051	0.100	0.039	0.030
142	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94	0.038	0.010	0.015	0.008	0.007	0.020	0.055
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000
129	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92	0.000	0.000	0.000	0.000	0.000	0.000	0.000
66	0.000	0.015	0.000	0.000	0.000	0.000	0.000

(continued)

Table 2. (cont.)

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
sIDHP-1							
(N)	20	50	49	29	35	102	90
100	0.825	0.880	0.918	0.879	0.786	0.882	0.828
74	0.100	0.100	0.051	0.103	0.200	0.078	0.061
142	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94	0.075	0.020	0.031	0.017	0.014	0.039	0.111
129	0.000	0.000	0.000	0.000	0.000	0.000	0.000
136	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92	0.000	0.000	0.000	0.000	0.000	0.000	0.000
s IDHP-2							
(N)	20	50	50	30	36	102	90
100	0.950	0.820	1.000	1.000	1.000	1.000	1.000
150	0.050	0.150	0.000	0.000	0.000	0.000	0.000
83	0.000 0.000	0.000	0.000	0.000	0.000	0.000	0.000
		0.000	0.000	0.000	0.000	0.000	0.000
66	0.000	0.030	0.000	0.000	0.000	0.000	0.000
LDH-B1				30			
(N)	20	50	50	1.000	1.000 36	102	90
100	1.000	1.000	1.000			1.000	1.000
LDH-B2							
(N)	20	50	50	30	36	102	90
100	1.000	0.990	0.960	1.000	0.986	0.985	0.983
112	0.000	0.010	0.040	0.000	0.014	0.015	0.017
LDH-C							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	0.980	1.000
90	0.000	0.000	0.000	0.000	0.000	0.020	0.000
84	0.000	0.000	0.000	0.000	0.000	0.000	0.000
sMDH-A1,2							
(N)	20	50		30	36	102	90
100	1.000	1.000	1.280	1.000	1.000	1.000	1.000
sMDH-B1,2							
(N)	20	50	50	30	36	102	90
100	0.987	0.975	1.000	1.000	0.979	0.997	0.994
121	0.000	0.000	0.000	0.000	0.000	0.000	0.000
70	0.000	0.000	0.000	0.000	0.000	0.000	0.000
83	0.000	0.000	0.000	0.000	0.000	0.000	0.000
126	0.012	0.025	0.000	0.000	0.021	0.003	0.006

(continued)

Table 2. (cont.)

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
mMDH-2							
(N)	20	50	50	29	36	102	90
100	0.525	0.610	0.630	0.569	0.847	0.721	0.650
200	0.475	0.390	0.370	0.431	0.153	0.279	0.350
mMDH-3							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
sMEP-1							
(N)	18	49	50	30	36	102	90
100	0.000	0.010	0.230	0.167	0.167	0.123	0.006
92	1.000	0.990	0.770	0.833	0.833	0.877	0.994
sMEP-2							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	0.989
78	0.000	0.000	0.000	0.000	0.000	0.000	0.011
MPI							
(N)	20	50	50	30	36	102	90
100	0.875	0.780	0.950	0.933	0.944	0.877	0.978
109	0.125	0.220	0.050	0.067	0.056	0.123	0.022
PGDH							
(N)	20	50	50	29	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGM-1							
(N)	20	50	50	29	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGM-2							
(N)	20	50	50	29	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
PGK-2							
(N)	20	50	50	30	36	102	90
100	0.350	0.180	0.000	0.033	0.083	0.152	0.117
90	0.650	0.820	1.000	0.967	0.917	0.848	0.883
PEPA							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1.000	1.000	0.995	1.000
90	0.000	0.000	0.000	0.000	0.000	0.005	0.000

(continued)

Table 2. (cont.)

COLLECTIONS 10 THROUGH 16

LOCUS/ALLELE	EF SALMON	HERD CK	CAMAS	NF SALMON	LOLO	DWORSHAK H	E FORK H
PEPB-1							
(N)	1.000 20	0.820 50	50	30	36	102	90
100			0.950	0.900	0.750	0.892	0.972
130	0.000	0.180	0.050	0.050	0.056	0.025	0.028
-350	0.000	0.000	0.000	0.050	0.194	0.083	0.000
PEPD-2							
(N)	20	50	50	30	36	98	90
100'	1.000	1 .ooo	1.000	1.000	1.000	1.000	1.000
107	0.000	0.000	0.000	0.000	0.000	0.000	0.000
PEP-LT							
(N)	20	50	50	30	36	102	90
100	0.975	0.930	0.920	1.000	0.986	0.936	0.856
110	0.025	0.070	0.080	0.000	0.014	0.064	0.144
[illegible]-1							
(N)	20						
-100	1.000	0.940 50	50	30	36	102	90
			0.900	0.950	0.778	0.902	0.900
-260	0.000	0.060	0.100	0.050	0.222	0.098	0.100
mSOD							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1.000	1 .ooo	1 .ooo	1.000	1.000
142	0.000	0.000	0.000	0.000	0.000	0.000	0.000
TPI-1							
(N)	20	50	50	30	36	102	90
100	1.000	1.000	1 .ooo	1 .ooo	1.000	1 .ooo	1 .ooo
TPI-2							
(N)	20	50	50	30	36	102	90
100	1.000	1 .ooo	1.000	1.000	1.000	1 .ooo	1 .ooo
TPI-3							
(N)	20	50	50	28	36	102	90
100	1.000	1.000	1.000	1.000	1.000	1.000	1.000
TPI-4							
(N)	20	50	50	30	36	102	90
100	0.925	0.750	0.870	0.950	0.917	0.902	0.856
104	0.075	0.250	0.130	0.050	0.083	0.098	0.144
75			0.000	0.000	0.000	0.000	0.000
96	0.000 0.000	0.000 0.000	0.000	0.000	0.000	0.000	0.000
102	0.000	0.000	0.000	0.000	0.000	0.000	0.000

TABLE 3. Genetic variability in 11 1991 Idaho Chinook collections - 46 loci (sAAT-1,2, sMDH-A1,2, sMDH-B1,2, GPIr, & sMEP-2 not included); standard errors in parentheses.

COLLECTION	MEAN SAMPLE SIZE PER LOCUS	MEAN NO. ALLELES/ LOCUS	PERCENTAGE OF LOCI POLYMORPHIC*	MEAN HETEROZYGOSITY DIRECT-COUNT	HDYWBG# EXPECTED
LEMHI R.	49.2 (0.3)	1.4 (0.1)	37.0	0.052 (0.014)	0.053 (0.014)
PAHSIMEROI R.	49.6 (0.2)	1.4 (0.1)	32.6	0.054 (0.014)	0.054 (0.014)
CROOKED FORK CK.	48.1 (0.7)	1.5 (0.1)	43.5	0.061 (0.016)	0.060 (0.015)
RED R.	48.7 (0.4)	1.3 (0.1)	30.4	0.040 (0.012)	0.042 (0.012)
S.F. SALMON R.	49.8 (0.4)	1.5 (0.1)	41.3	0.057 (0.015)	0.056 (0.014)
BEAR VALLEY CK.	49.3 (0.3)	1.4 (0.1)	41.3	0.061 (0.017)	0.063 (0.017)
W.F. YANKEE FORK	49.4 (0.2)	1.4 (0.1)	34.8	0.062 (0.018)	0.058 (0.017)
HERD CK.	49.5 (0.2)	1.3 (0.1)	30.4	0.065 (0.020)	0.061 (0.018)
CAMAS CK.	48.9 (0.5)	1.3 (0.1)	32.6	0.068 (0.021)	0.058 (0.016)
DWORSHAK HAT.	101.3 (0.3)	1.5 (0.1)	39.1	0.058 (0.014)	0.058 (0.014)
EAST FORK HAT.	88.6 (0.7)	1.3 (0.1)	32.6	0.049 (0.014)	0.051 (0.015)

* A locus is considered polymorphic if more than one allele was detected

Unbiased estimate (see Nei, 1978)

Dendrograms were produced using two different genetic distance statistics, **Nei's** (1978) unbiased genetic distance and the Cavalli-Sforza and Edwards (1967) chord distance (Figures 1 and 2), and using 29 of the 31 variable loci (IDDH-2 and sMEP-2 excluded). Both provide a similar representation of the relationships among the 11 collections. Genetic distances among collections were small. The collections that clustered together the closest were not always geographically close. For example, two upper Salmon River collections, Lemhi River and Pahsimeroi River, were more similar to two Clearwater collections, Dworshak Hatchery and Red River, than other Salmon River tributaries.

Results of the G-tests done for all possible pairs of the 11 large collections (29 variable loci) showed only one pair, Pahsimeroi River vs. Red River, not significantly different ($p > 0.05$). One other pair, Lemhi River vs. Red River was significantly different at $p \leq 0.05$ but not at $p \leq 0.01$. All other pairs of collections were genetically distinct enough from each other to be significantly different ($p \leq 0.01$).

CONCLUSIONS & RECOMMENDATIONS

The small size of the juveniles collected for this study presented some limitations, but did not prevent us from doing an accurate and extensive electrophoretic survey. Without heart tissue, several loci can not be screened, and some verification of variation observed in other tissues can not be made. The small sample size for five of the collections did not allow for much data analysis, but if more fish for these same localities can be collected next year, data from the two years can be combined and the analysis completed. Although collections with 50 fish were used as an adequate representation of the genetic characteristics of a population, having a 100 fish sample is considered optimal. Again, next year's samples can be combined with the 1991 data for analysis. Temporal comparisons between years could also be made.

Genetic variability within collections proved to be higher than what has been reported in older studies (e.g. Winans 1989). Our current ability to do much more extensive electrophoretic analyses is the primary reason for this result. The differences in genetic variability between collections were generally large enough to provide evidence for population discreteness. However both the G-test and cluster analyses showed the Red River and Pahsimeroi collections to be genetically similar. The Red River and the Lemhi River collections also shared some similarities. Since geographic proximity does not explain this relatedness, it will be interesting to know if stock transfers have occurred between these localities.

The rare allelic variants that were found throughout the 16 collections were at low frequencies, but they do contribute unique characteristics to these Snake River chinook. Several rare alleles, sAAT-1,2*105, sIDHP-2*66, sMDH-B1,2*126, and mSOD*142, were not observed in 11 other Idaho chinook populations analyzed by Waples et al. (1991).

If complete and larger samples from these 16 localities can be obtained in the next year, a more extensive comparative analysis can be done. WDF has comparable genetic data for many chinook stocks throughout the Columbia basin, Puget Sound, and coastal regions, and we could analyze relationships among these stocks and the Snake stocks. A complete genetic stock characterization for these Snake populations will also allow us to use them in mixed-stock fishery analyses. The ability to measure more accurately the contributions of Snake stocks to Columbia River fisheries' harvests should enhance conservation efforts.

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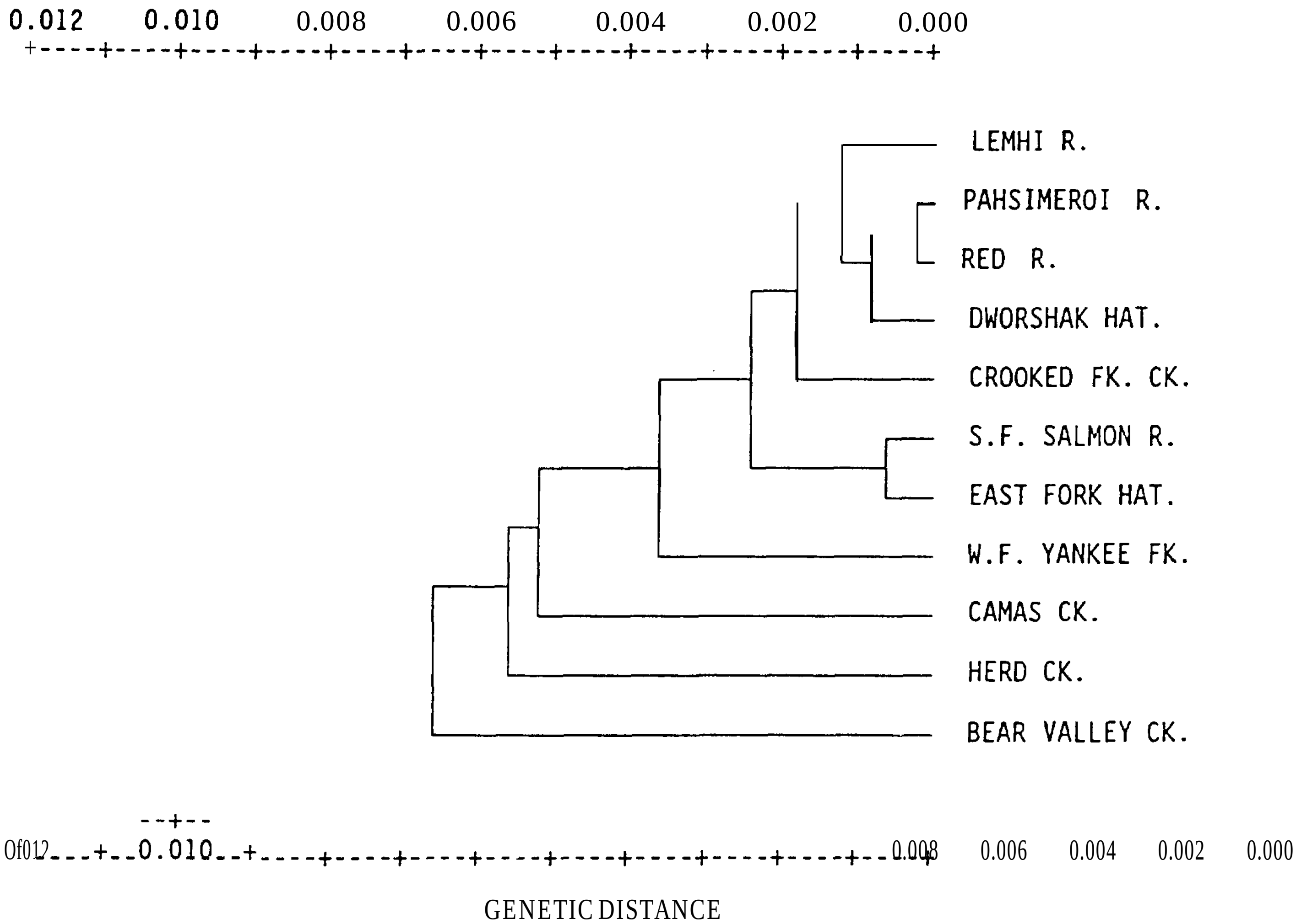

Figure 1. Dendrogram of Nei's unbiased genetic distances calculated over 29 loci in 11 Idaho chinook baseline collections (unweighted pair-group method used for cluster analysis).

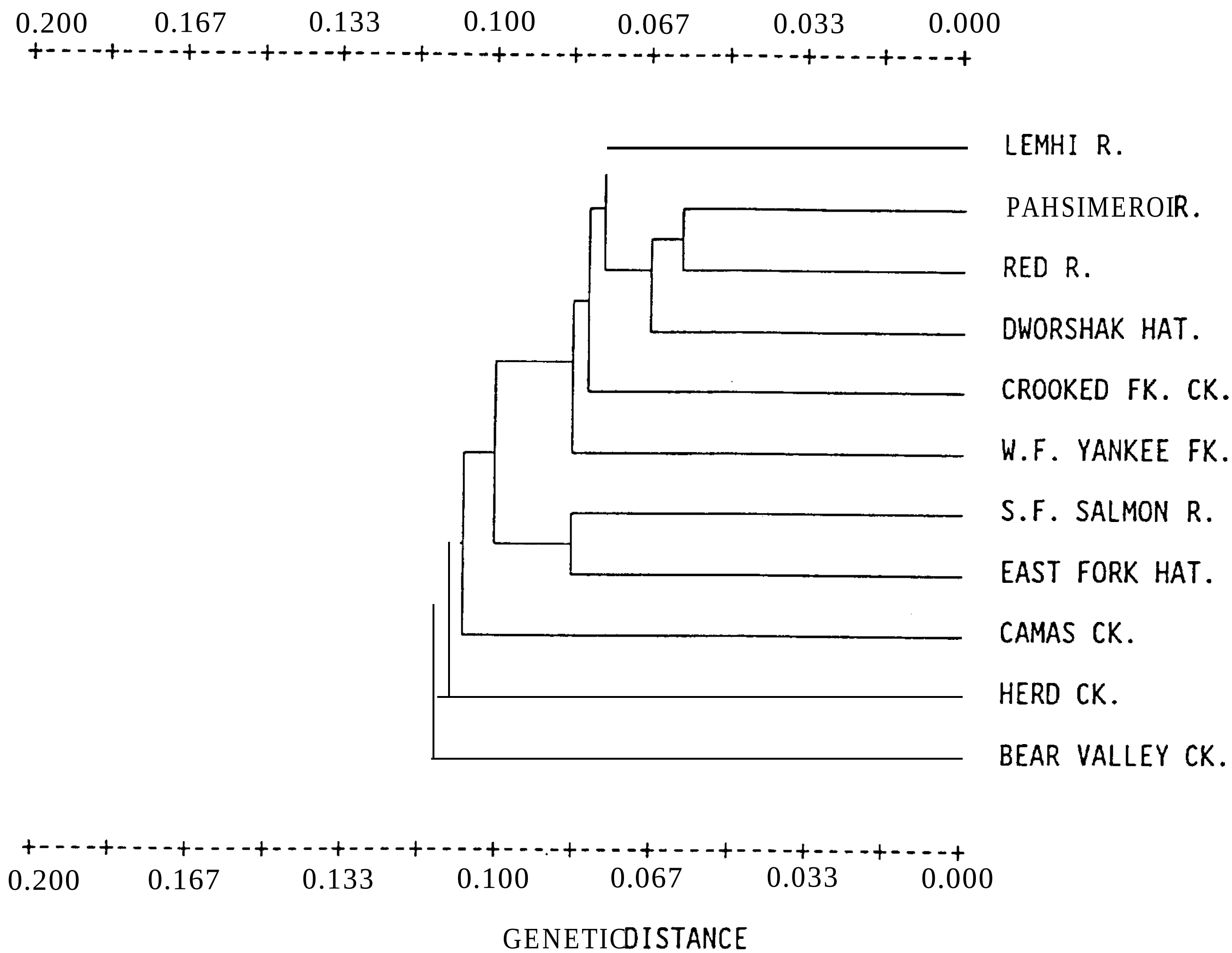

Figure 2. Dendrogram of Cavalli-Sforza & Edwards Chord distances calculated over 29 loci in 11 Idaho chinook baseline collections (unweighted pair-group method used for cluster analysis).

Appendix I. Electrophoretic screening protocol for 1991 Idaho juvenile chinook baseline samples.

MUSCLE

TRIS-GLY (35 mm origin) 5 1/4 hrs @ 600V (max. 90 mA) LKB THICK GEL

PEPB (PEPB-l=PEPB-H)
PGM + MPI (PGM-1 & 2) ***cut anode in 2 pieces (lower half -2.5 cm) & stain separately** score PGM auicklv
GPI (GPI-Bl, B2, A & r) score very quickly
PEP-LT (PEPA & PEP-LT)
SOD (sSOD-1) c only
TPI (TPI-1, 2, 3, & 4) a + c
ADA (ADA-l & 2)
CK (CK-Al & A2)

CAME 6.8 (35mm origin) 5 1/4hrs @ 250V (max. 90 mA) THICK GEL

AH (mAH-3 & 4)
PGK (PGK-2) score quickly
MDH (sMDH-A1,2 & B1,2 & mMDH-1, 2, & 3) a + c
AAT (sAAT-1,2 & mAAT-1 & 2) a + c
IDHP + PGDH (mIDHP-1, 2 & sIDHP-1,2C + PGDH)
GAPDH (GAPDH-2)

TC-4 (40mm origin) 5 hrs @ 90 mA (max. 250V) LKB THICK GEL

PEP-LT + PEPB (PEP-LT & PEPB-L) a + c
AAT (sAAT-1,2 & mAAT-1 & 2) a + c
IDHP (sIDHP-1,2T)
MEP (sMEP-1 & 2) use 15mg oxaloacetate
GR
PEPD (PEPD-2)
SOD (mSOD) a + c

EYE

TRIS-GLY (35mm origin) 5 1/4 hrs @ 600V (max. 90 mA) THICK GEL

LDH (LDH-Bl, B2, & C)
AAT (sAAT-3)
PEP-LT (PEPA & PEP-LT)
MPI
TPI (TPI-3 & 4)
HAGH

CAME 6.8 (35 mm origin) 5 1/4 hrs @ 250V (max. 90 mA) THICK GEL

AAT (sAAT-3)
AH (mAH-1, 2, 3 & 4)
IDHP (sIDHP-1,2C)
PGK (PGK-2)
GAPDH (GAPDH-4)
LDH (LDH-Bl, B2 & C)

(continued)

LIVER

TRIS-GLY (35mm origin) 5 1/4 hrs @ 600V (max. 90 mA) THICK GEL

PEPB (PEPB-l=PEPB-H)
IDDH (IDDH-1 & 2)
ADH c only
ADA (ADA-l & 2)
AH (sAH)
SOD (sSOD-1) a + c
HAGH

CAME 6.8 (35 mm origin) 5 1/4 hrs @ 250V (max. 90 mA) THICK GEL

LDH (LDH-B2)
AAT (sAAT-4)
ADH c only
AH (sAH)
IDHP (sIDHP-1,2C)
GR
MDH (sMDH-A1,2 & sMDH-B1,2)

TC-4 (40mm origin) 5 hrs @ 75 mA (max. 250V) LXB THIN GEL

PEPB (PEPB-l=PEPB-L) a + c
AAT (sAAT-4)
IDHP (sIDHP-1,2T)
MEP (sMEP-1 & 2)
PEPD (PEPD-2)

HEART

CAME 6.8 (35mm origin) 5 1/4 hrs @ 250V (max. 75 mA) THIN GEL

G3PDH (G3PDH-3)
AH (mAH-1, 2, 3, & 4)
MDH (sMDH-A1,2 & B1,2 & mMDH-1, 2, & 3) a + c
AAT (sAAT-1,2 & mAAT-1 & 2) a + c
GAPDH (GAPDH-2 & 3)

TC-4 (40mm origin) 5 hrs @ 90 mA (max. 250V) LKB THICK GEL

PEPB (PEPB-l=PEPB-L) c only from middle
AAT (sAAT-1,2 & mAAT-1 & 2) a + c
MEP (sMEP-1 & 2) use 15mg. oxaloacetate
IDHP (sIDHP-1,2T)
SOD (sSOD-1 & 2 & mSOD) a + c
GR
PEPD (PEPD-2)

Appendix 2. Chinook variable loci and alleles - 1992

WDF ALLELE CODES - STANDARD RELATIVE MOBILITIES

LOCUS	1	2	3	105	(91*)	5	6	7	8	9	10	TISSUE
sAAT-1,2	100	85										M,H
sAAT-3	100	90	113	95*	71*							E
sAAT-4	100	130	63									L
mAAT-1	-100	-77	-104	XX	(-119)*							M,H
mAAT-2#	-100	r-125)	[-90]									M,H
mAAT-3#	100	-450										H
ADA-l	100	83	(69*)	96*	f*							M,E,H
ADA-2	100	105	96*	85*	["3" & "4" on TC-4 buffer]							M,E,H
ADH	100	-52	-170	[on hi pH]								L
sAH	100	86	112	108@	69	118*						L
mAH-1	100	65	130*									H
mAH-2#	100	83										H
mAH-3	100	126	74									M,H
mAH-4	100	119	112	109*	(136*)							M,H
CK-A1#	100	-450										M
CK-A2#	100	s?										M
CK-C1#	100	[s]										E
CK-C2#	100	[105]	[95]									E
CK-B#	100	96										E
GAPDH-2#	100	22										H
GAPDH-3#	100	123										H,M
GPI-B1#	100	xx	(175)									M
GPI-B2	100	60	135	24								M
GPI-A	100	105	93	85*								M,E,H
GPI-r	100	{%}										M
GR	100	85	110	89*	117*	71*		(vf*)				M,E,H,L
G3PDH-3#	100	[112]	[90]									H
G3PDH-4#	100	s?										M
HAGH	100	143	131*	65*	28*							M,H,L
IDDH-1#	100	0										L
IDDH-2#	100	61										L
mIDHP-1#	100	147	30	178								M,E
mIDHP-2	100	154	50*	f/TC4*	122*							M,E
sIDHP-1,2	100	127	74	142	50	94	83	129	136*	92*	&&	M,H,E,L
sIDHP-1	100		74	142		94	(83)	129	136*	92*	&&	M,H,E,L
sIDHP-2	100	127			50		83				&&	H,E,L
LDH-B1#	100	-60										E,L
LDH-B2	100	112	134	71	56*							E,L
LDH-C	100	90	84									E
sMDH-A1,2	100	120	27	-45	(160*)	(27 measures 50 on CAME6.8)						M,H,E
sMDH-B1,2	100	121	70	83	126*	null/f*	null/s*					M,H,L
mMDH-1	-100	-900										M,H
mMDH-2	100	200	~180*									M,H
mMDH-3#	100	190										M,H
sMEP-1	100	92	105	86*								M,H
sMEP-2	100	(78)										M,H
mMEP-1#	100	150	-50									H
MPI	100	109	95	113	103*	ms*	vs*					M,H,E
PEPA	100	90	86 81*	XX	(~111*)	(86 comigrates with 100 on TC-4)						M,E,H,L

(cont.)

Appendix 2. Chinook variable loci - (cont.)

WDF ALLELE CODES & STANDARD RELATIVE MOBILITIES

LOCUS	1	2	A	4	5	6	7	8	9	10	TISSUE
PEPB-1	100	130	-350	(s* = old 45 or68 ?)							M,E,H,L
PEPB-2	100	108									M,H
PEPD-2	100	107	83*								M,H
PEP-LT	100	110	(120*)	88*	(120 on TC-4 only)						M,H
PGDH	100	90	85	(95*)	(109*)						M,E,H
PGK-2	100	90	74*	(ms*)							M,E,L
PGM-1	100	210	165*	50*							M,H
PGM-2	100	166	136	(~145*)	63*						M,H,L
PGM-3,4#	100	96	90	i08	86						H,L
sSOD-1	-100	-260	580	1260	-175*	(~-160*)					M,H,E
sSOD-2#	100	[120]									H
mSOD	100	142	141$*	~70*							M,H
TPI-1#	100	(-155?)									M,E,H
TPI-2#	100	-400									M,E,H
TPI-3#	100	[104]	[106]	[91]							M,E,H
TPI-4	100	[104]	[75*]	[96*]	[102*]	[101*]					M,E,H

* = allele is not currently recognized in the coast-wide baseline
( ) = allele has only been seen in mixed-stock fishery samples
\# = locus is not currently supported by the coast-wide baseline
[ ] = scoring of variant & mobility of allele determined from heterodimer
@ = mobility standards are necessary to distinguish the 108 and 112 alleles, or run side-by-side; measure on CAME 6.8
{ } = allele does not generate an isozyme of different mobility and is only scored reliably in the homozygous state
% = allele represents the absence of the GPI 1/3 heterodimer
$ = allele has approximately the same mobility as the "142" (on high pH buffers, but not on TC-4) and has greatly reduced activity, therefore the phenotypes are distinguishable
&& = the "11" allele is 66* and is from IDH-4
the "12" allele is ~126* and is from IDH-3
the "13" allele is 72* (TC-4) and is from IDH-3 (="74" on CAF25.8)
the "14" allele is ~132* and is from IDH-3; on TC-4 looks like a 129/ 100 or 127/127, on CAME6.8 looks like a 136/100.

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